FLIGHT
and
AIRCRAFT ENGINEER

First Aeronautical Weekly in the World

Founded 1909

No. 2125. Vol. LVI. THURSDAY, 15 SEPTEMBER, 1949.

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SUBSCRIPTION RATES
Home : Twelve months, £3 1s. 0d. Six months, £1 10s. 6d.
Overseas : Twelve months, £2 18s. 6d.
BY AIR : To any country in Europe (except Poland). Twelve months, £5 1s. 0d. Six months, £2 10s. 6d. Canada and U.S.A. Six months, $16.

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Portents of Farnborough

AND so the sunniest and altogether the most memorable of S.B.A.C. Displays is over: the tents are folded and the smartly furbished fighters, bombers, transports and trainers have been cleared for departure by the Farnborough control staff, whose skill and good nature, be it said, were a real contribution to an unparalleled success. In tens of thousands of British homes, enthusiasm for British skill runs at the highest level since the war; and overseas guests of the Society, homeward bound, are stocked with material for reflection concerning some truly modern, yet practical, aircraft, power plants, techniques and equipment. A few of these visitors remain with us to learn more about the qualities which place Britain's best so far ahead of anything "back home." When they are possessed of the knowledge they desire they will buy, and, we believe, buy heavily, for in air fighting and air commerce alike, the second-best brings quick disaster.

The reasons underlying the present somewhat unbalanced character of the industry in respect of aircraft categories are, we believe, sufficiently understood not to need reiteration. We can, however, contemplate the future with a confidence immeasurably fortified by "Farnborough," or, more precisely, by a single performance there. We refer to the exhilarating presentation of the English Electric Canberra, the first of a series of jet bombers which will bring about a rebirth of R.A.F. Bomber Command. In predicting that Britain's new family of bombers will not only match the quality of her new transport aircraft, but will utterly transcend present-day standards of performance, we are not unmindful of the exceptionally arduous research necessary for the fulfilment of our ambitious bomber programme. Here again, the Display provided a sign (admittedly in the form of a single aircraft —the Avro 707), that the pattern of research which has already brought forth the D.H. 108 and A.W. 52 is being imaginatively worked out.

But more than one S.B.A.C. Display will pass by (and may each be as encouraging as that just ended) before large aircraft of revolutionary delta or crescent-wing design perform for the Society's guests.

What of the Future?

What is the next step? The answer is one that should be made widely known, or many people may find themselves disappointed. For, in spite of the magnificent achievements of the industry, the latest British aircraft which have recently been the talk of the world have done no more than reach first base. Not one new civil or military type with gas-turbine power units has gone into service during the last twelve months, and none is likely to do so in the next year. The Comet, Viscount, Ambassador and others will not be ready for service until 1951 at the very earliest, and the Brabazon not until later still. On the military side we can expect new types of naval aircraft, designed with anti-submarine warfare uppermost in mind, and high-speed fighters capable of all-weather utilization to be in service at much the same time.

The answer to our question is, then, that the months to come must and will be spent in intensive development preparatory to the introduction of gas-turbine-powered aircraft into airline service. Fuel consumptions will be reduced, life of components increased and, in particular, every effort made to solve the problem of anti-icing protection. We must also learn more about traffic handling and about conditions when flying at high speed and high altitude in large aircraft over the Atlantic and Empire routes. S/L. Waterton—Meteor pilot—has rightly sounded the warning against unthinking optimism which would tend to blind one to these shortcomings in present-day knowledge. The de Havilland Company have also made it clear that they have done no more to date than make an exceptionally good beginning to a long period of development. Given the time, however, everyone has absolute confidence in the ability of our technicians and pilots to complete quickly and successfully the work in hand, thus maintaining and even increasing the lead they have wrested in the face of world competition.

A SHOW TO REMEMBER

S.B.A.C.'s Superb Flying Display and Static Exhibition: The Inaugural Banquet

FARNBOROUGH, 1949, has come and gone. That it has been the greatest show of its kind, in every connotation of the word great, there can be no doubt whatever. During the "trade" days over 300 official guests from forty-odd foreign and British Commonwealth countries attended, and there was an unspecified number of "unofficial" foreign visitors; every member of the British aviation and associated industries who could tear himself from his desk, laboratory or bench was there; and on the Saturday and Sunday the general public were admitted in hot but happy hordes, to the tune of something like 260,000 for the two days.

Weather was perfect for the purpose, if a little trying on eyes peering into a blazing sky; organization, both in the staging of the flying display and in the control of the crowds, left little room for criticism; and the most untoward incident of the whole week was a small grass-fire.

Despite the strain that had undoubtedly been imposed on pilots by four days of precisely timed—and in many cases, very high-speed—demonstration, the standard of flying on the public days was in every way as magnificent as that seen earlier by professional eyes. The display programme corresponded almost exactly to that of the trade days, and in addition, only at the week-end was seen the reassuring spectacle of three four-engined transports—Viscount, Hermes IV and Apollo—flying strongly on one power-unit apiece. A two-seat Meteor 7 "stood-in" for the new Mk 8 for the last two days, but its performance was every bit as impressive, and the "speed twins"—Wade and Lithgow—demonstrated the Hawker P.1052 and Supermarine 510 with aerobatics and 600-plus "flash-pasts" even more dramatically than during the week. The "Five-Ten," incidentally, was earlier reported by Lithgow to have equalled, in one of its shallow dives, the world's speed record of 670 m.p.h.

Few guests would hesitate in agreeing that the first S.B.A.C. Flying Display banquet, held at the Dorchester Hotel, London, on Tuesday, September 6th—the eve of the opening of the Exhibition itself—was a resounding success, worthy indeed of the great show it heralded. More than 800 guests, a large proportion of whom were delegates from foreign governments, Services, airlines and aircraft industries, and among whom were representatives of the Western Union, met and dined in an atmosphere of marked cordiality. The dinner was one of welcome to these foreign guests, and it took the place of the opening luncheons of previous years. Sir Roy Dobson, C.B.E., J.P., F.R.Ae.S., managing director of A. V. Roe, took the chair as this year's president of the S.B.A.C. He will be succeeded in 1950 by Mr. W. T. Gill, the present vice-president.

IN the leading article on the previous page, and on these two pages, we give a general summing-up of the S.B.A.C. Display, together with, here, a report on the inaugural banquet; in our special 12-page photogravure section (pp. 343-354) we present a detailed account of the individual flying demonstrations; and on pp. 355-358 some highlights of the Static Show are described

Proposing the toast of "The Guests," Sir Roy was engagingly candid as to the purpose of the Exhibition: they did not hold it for fun, he said, or merely to show off aircraft—they wanted to sell their visitors something.

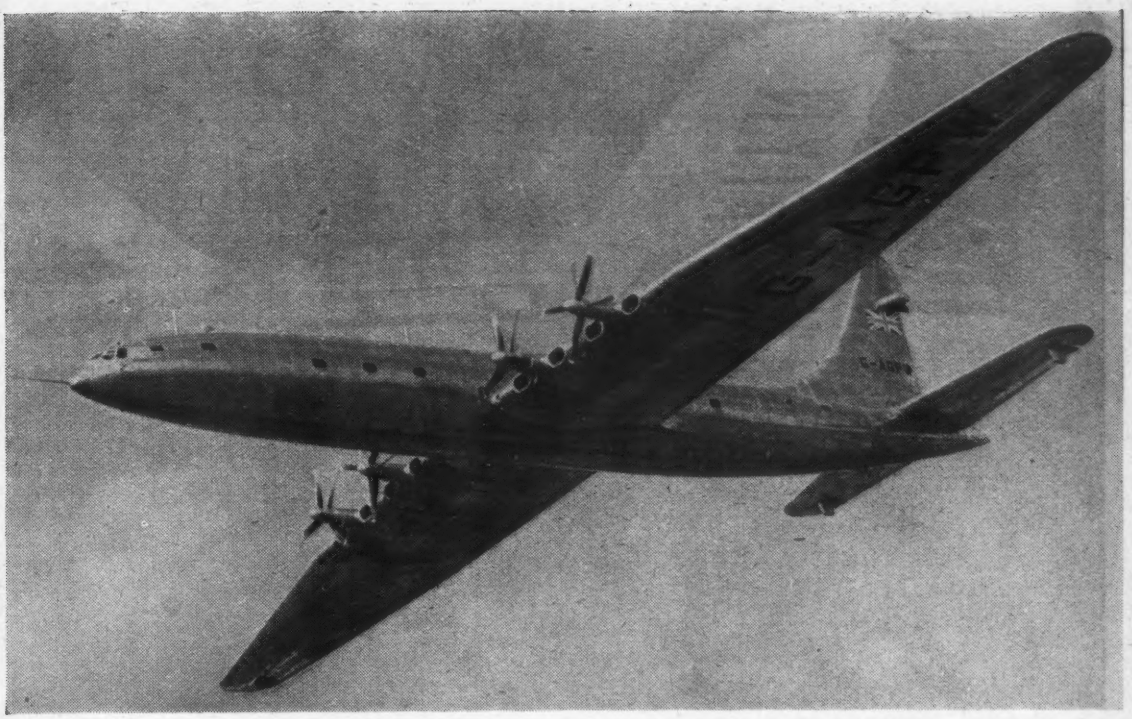
He was proud to be able to say that, since the last Show, exports of British aircraft had increased, particularly to the hard-currency countries; in the first six months of 1949 exports had been considerably more than those for the whole of 1946, and they felt confident of reaching the substantial target of £33 million which the President of the Board of Trade has set up.

Reviewing the Show, Sir Roy said that, without appearing boastful, he could claim that nowhere in the world would they find aircraft of more advanced conception and design and backed by such an unsurpassed development programme.

Going on to welcome the guests, the president referred in particular to what he called "the unusually large representation of those experts and hard-headed judges of commercial aircraft—the American airline companies"; he hoped that their presence was significant.

Turning to the future shape of co-operation within the British Commonwealth, the speaker said that it was perhaps a straw in the wind that within the past few months the S.B.A.C. had created membership categories designed to bring in Empire manufacturers, while some of his hearers would probably have noticed the increasing financial and technical interest taken in Dominion aircraft industries by the Society's members. Here the industry was on the threshold of great and exciting developments.

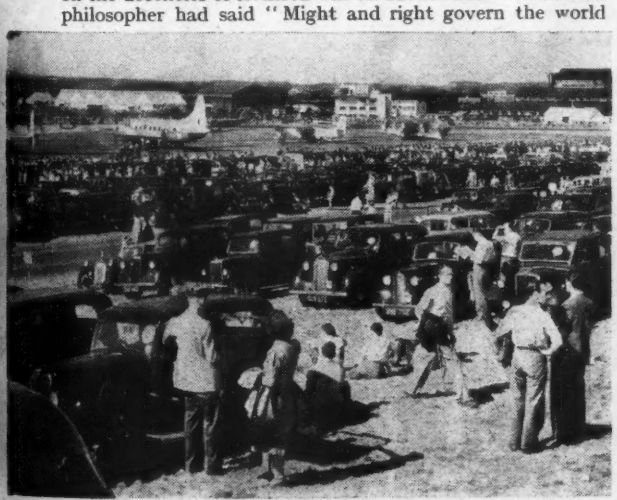
A general view of the great crowd which attended the show on Saturday. "Flight" photograph



Pegg displaying the Bristol Brabazon I on Thursday. Unfortunately this was the only visit the "Brab" was able to make.

Replying to the toast, Marshal of the Royal Air Force Lord Tedder, G.C.B., Chief of the Air Staff, neatly summed up the feeling well known to many people engaged in aviation, namely, that apparent in their relations with the airmen of other countries. "It is an indication of the reality of this spirit that I instinctively shrink from using the word 'foreign' in connection with airmen," he said. He did not think he was being indiscreet in saying that in the discussions aimed at ensuring a common security for all, it had been in the field of air defences that progress had been most rapid—simply because airmen thought in a common language, though nations might speak with different tongues.

Lord Tedder said he found it difficult to understand the mental processes of those "intellectual ostriches" who regarded the aircraft and bomb as "disgusting intrusions on the decencies of civilized war on battlefields." A French philosopher had said "Might and right govern the world —might till right is ready," but surely one of the main lessons of the past twelve years had been that right was still unable to govern unless backed by might.



Speaking of the aircraft on show, the Chief of the Air Staff referred to the "very good-looking youngster" which would be taking the place of the grand old generation of Halifaxes, Stirlings, Lancasters and Lincolns. He recalled that even at the time of Germany's collapse under Allied bombing her production of fighters exceeded the total combined British and American production; so, much as his hearers would relish the beauty and performance of the fighters to be seen at the Exhibition the next day, it was on the punch forecast by the Canberra that one's mind concentrated.

Proposing the toast of the British aircraft industry, Mr. G. R. Strauss, Minister of Supply, outlined the financial, technical and other help given by his Ministry to the aircraft industry. Congratulating the industry on its contribution to the export drive, he supplemented Sir Roy Dobson's figures by saying that during the first six months of this year exports had been at an annual rate of about £32 million compared with £5½ million for the whole of 1938. Half these exports went to hard-currency countries.

Mr. Strauss concluded by summing up the problems to be solved by the aircraft industry: they included the need to cut down the time taken to design and develop new types; the importance of providing spares concurrently with the delivery of new aircraft and engines; and the question of improving ancilliary equipment.

In responding to the toast, Mr. W. R. Verdon-Smith (deputy president of the S.B.A.C.) said that, as the final speaker, he regarded himself "as a sort of long-stop," and, taking up his position in the oratorial field accordingly, commented on previous speakers' references to the time taken to develop an aircraft and the need for simplification. Any attempt to shorten the development period, he maintained, was likely to be offset by the increasing complexity of aircraft. Regarding spares provisioning, he realized that this was a case where the customer was always right. Constant attention was necessary, but precipitate action might lead to the wrong course.

APOLLO APPRAISAL

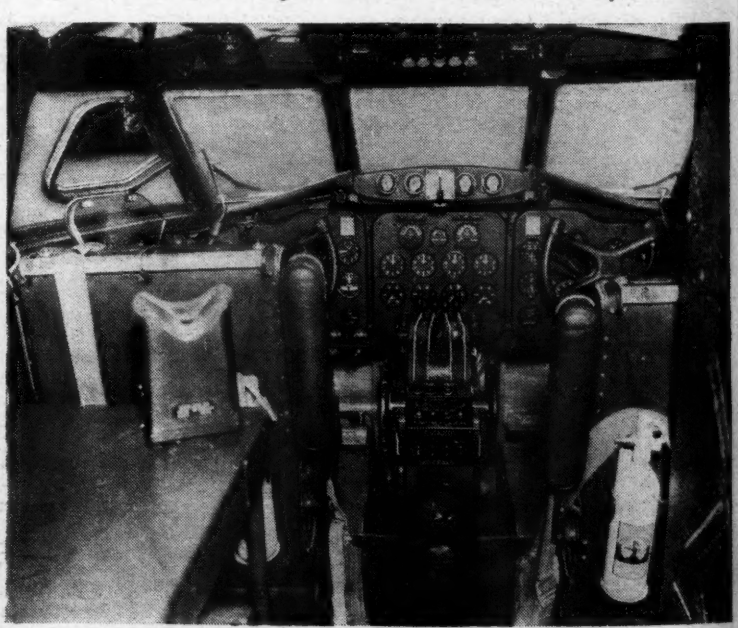
Flight Experience of a Mamba-powered Airliner

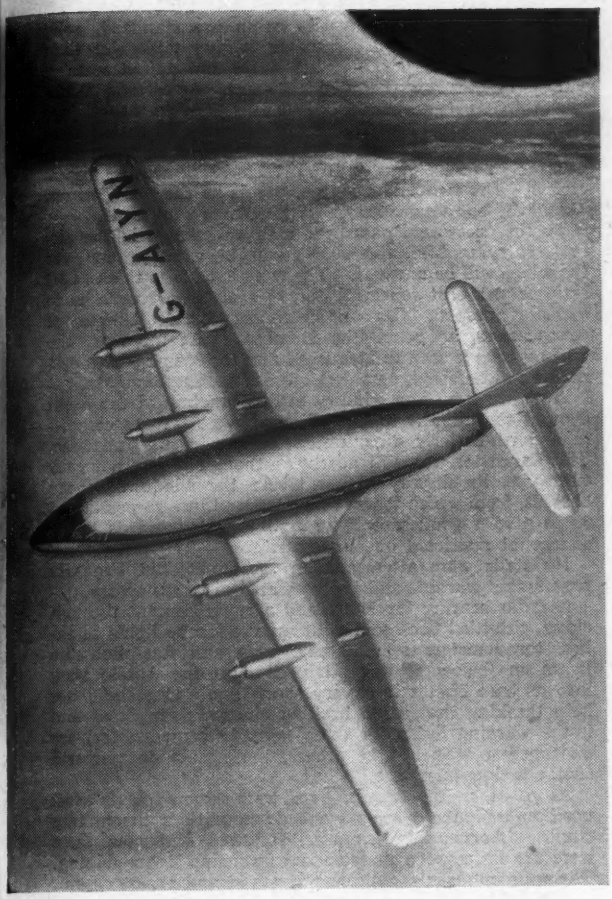
Illustrated by "Flight" Photographs

DURING last week a very large number of visitors to Farnborough were able to familiarize themselves with details of the Apollo, one of the three British four-engined turboprop airliners now flying. They were also able to appreciate, to some extent, its lively performance. Immediately before its S.B.A.C. appearance the Editor was given an opportunity to fly in the Apollo, and impressions and information gained during the flight form the subject of the following description.

To date, the Apollo has completed about 30 hours since its first flight on April 10th. It has encountered no serious troubles at all, but some delays in development have been occasioned by flap jacks proving insufficiently powerful to lower all the sections at the higher circuit speeds, and by a tendency toward nosewheel wobble. The first shortcoming has been temporary overcome by cutting out the central flap section under the fuselage. The remaining area has proved adequate but, in any case, more powerful jacks will be available shortly. The wheel wobble was not manifest until the aircraft was first landed on runways at Bitteswell: previously it had been operated from grass at Baginton Modifications to the damping arrangements solved the wobble tendency, but were found to have affected the nosewheel steering adversely. This, too, has now been remedied.

Generally speaking, the Appollo has shown great promise, and so good has been the directional control under all conditions with the simple horn-balanced rudder that a design for a special rudder (in two sections, with hydraulically operated corrector area) as used for the elevons of the A.W.52, may not be heard of again. It is understood, incidentally, that a





THE unusual and striking photograph above was secured as Mr. Franklin crossed under the photographic aircraft. Lower left: Tidy cockpit-layout, with all engine instruments on the central panel and trimmers and controls on the pedestal. Below: After end of the cabin, showing A.S.T. seats, two diminutive toilets, entrance door and luggage compartment.

similar corrector rudder has been designed for the Avro (Canada) C.102 Jetliner.

Fine-pitch stop arrangements for the Mamba airscrews appear to be satisfactory with 6 deg as the full fine limit and 26 deg for the withdrawable stop. First flights were made with a 10-degree fine-pitch stop, but this provided too much idling thrust. It will be remembered that the Mamba carries an automatic reverse-torque switch which gives protection against the sudden drag of windmilling in full fine (sometimes called "discing"). The switch is similar in effect to an automatic feathering device. However, as it works through the c.s.u., which could also fail, the manually withdrawable 26-degree flight-fine-pitch stop must be provided as a safeguard to cover high-speed flight failure of the c.s.u. Ultimately the manually withdrawable stop may be automatic through depression of the oleos on landing or, vice versa on take-off. The hand switch now permits the stop to be engaged on take-off as soon as the minimum flight-pitch is passed, the switch itself being operated as part of the pre-take-off drill.

Take-off on the occasion of our visit was somewhat delayed by a change of the port inboard Mamba, but the newly installed unit was run up and found correct first time. Mr. Franklin, Armstrong Whitworth Aircraft chief test pilot, took the Apollo round on a quick test circuit, and we then embarked for the flight, during which the accompanying photographs were secured by L. W.McLaren of our photographic staff.

Impressions from the Ground

During the test circuit the quietness of the Mambas in flight was noted, as was the rather slow and unusual retraction of the wheels. The movement of the pairs of main wheels is inward and slightly rearward, and they are mounted inboard and quite separate from the nacelles. To be precise, the wheels themselves move up reasonably quickly, but the doors, which follow, take several seconds more and look quite grotesque in the process.

Electric starters are now used for the axial Mambas, and it is necessary to reach relatively high r.p.m. before the turbine becomes self-sustaining. An outside power source is essential for the procedure and acceleration from stationary is rapid. The starting panel is in the roof, and the actions are simple enough: put master switch for starting circuit on, select engines in turn and press the energizing button for each. As the turbines get turning, the high pressure cocks, situated on the pedestal ahead of the power levers, are put on. In the cockpit the noise of the four Mambas running is slight and not unlike the high note of a singing kettle.

Conditions during a flight sometimes make it easy to form a wrong opinion of an aircraft. Sensations caused by rough air, for instance, make any flight less pleasant. Indirectly, too, the weather can intervene even on the ground, and for this reason a clonking and bonking during taxying and take-off over the sun-baked, rather rough grass field should not be held against the Apollo. The nosewheel is steered from a small control wheel inside and concentric with the main control "spectacles" for the first pilot. The brakes, too, are on the control wheel, which is rather unusual on such an aircraft.

There does not seem to be any particular ruling about the number of Mambas to be used for taxying, but four all set at ground idling speed of 8,000 r.p.m. give plenty—even a little too much—thrust for taxying on grass.

The aircraft having been lined-up on the runway with nosewheel straight, the simple take-off check is performed. This includes the usual actions—trimmers centralized (a degree starboard on rudder, perhaps), fine-pitch stop withdrawal switch operated, and flaps—they are of the three-position type, with selector levers on each side of the

Apollo Appraisal . . .

pedestal—lowered to 25 deg take-off stop. Between 8,000 and 11,000 r.p.m. the Mambas are treated with some caution on opening up, for it is possible to stall them and roast-up turbine blades. This does not mean, however, that Mambas are unduly "precious." For take-off they are opened up reasonably slowly to 11,000 and then banged open, if need be, to the full 14,500 r.p.m. Brakes are released and, with the nosewheel steering to aid direction-keeping, the Apollo is away in a hurry.

The nosewheel will come off at around 60 kt but may be left down, when light, until the aircraft is ready to unstick at 85-90 kt. With four engines pulling, the rate of climb at 34,000 lb weight is over 2,000 ft/min, and tests to date have shown that an outer engine cut as the aircraft climbs away from the ground at about 100 kt gives no cause for embarrassment to the pilot.

There are a number of indicator lights which may wink at the pilot on the ground or in the air. A green one tells him his nosewheel is central, four bright white ones on the pedestal that the withdrawable pitch-stops are engaged, four red ones on the starboard side that the Mambas are "reserve torquing" and four other red ones (day/night type), let into the feathering buttons, give fire warning.

Two Feathered on one Side

As the Apollo climbed away in pursuit of the photographic Lancaster, and later as it formated with it, it was noticeable that S/L. Franklin handled his aircraft with obvious ease and confidence bespeaking light, responsive controls. He had previously spoken of the simple flying characteristics of his machine, and after some normal demonstrations two Mambas were feathered on one side. This can be achieved almost instantaneously by cutting the high-pressure cocks. Fuel feed stops at once, and the reverse-torque warning light flashes on because the airscrew is turning the turbine. The reverse-torque switch also operates at once, moving the airscrew rapidly into full-coarse. Pressing the feathering button then does the rest. Small turboprops will not usually stop altogether, because they run so freely, and in practice they windmill very slowly (usually backwards), the drag increase being negligible. The airscrews also continue to turn for a long time after shut-down on the tarmac.

The Apollo remains very handleable on two engines and turns readily against them. Service ceiling on two engines is quoted as 15,000ft and on three, as 26,500ft.

Mambas give no trouble in relighting, and the procedure takes approximately nine seconds. The three-bladed D.H. airscrews unfeather in response to pressing the feathering button, and the Mambas pick up readily as soon as the high-pressure cock is switched on and the fire is relighted. During the starting-cycle on the ground, jet-pipe temperatures need watching and must not be allowed to exceed 700 deg C, but in the air there is little tendency for this to occur. The maximum jet-pipe temperature allowed for normal running is 590 deg C, and it is not usual to exceed 500 deg C under cruising conditions.

Among the relatively few engine instruments on the centre panel are four torquemeters reading in pounds per square inch. Their readings in flight vary between 50 and 80, and, to discover the shaft horsepower developed, one multiplies the torquemeter pressure by the r.p.m. and divides by a constant of approximately 1,940 (the flight crew use the year 1949 to help them remember).

Leaving the cockpit and walking back into the furnished cabin, it was possible to consider the ride from the passenger's viewpoint, although flying for some 45 minutes at 14,000-15,000ft without pressure or oxygen proved rather a strain, particularly as the climb—and, later, the descent—were rapid. Noise level was found to be a little better than the average for all modern transports, and sounds consisted of a deep rumble mixed with a just discernible whir as of reduction gearing. The whistle mentioned earlier could no longer be heard. Of vibration there was also the average amount, and this, it was said, was chiefly due to the airscrews and will be remedied.

On one side of the Apollo cabin are standard, solid paired seats by A.S.T., carrying folding tables on their backs, while on the other side single and paired seats of various makes are provided for trial. Armstrong Whitworth are to be congratulated on this sensible move. The passengers' view from the large windows is better than previously experienced in any other low-winged aircraft, and the general layout and roominess inside will be appreciated. The two toilet compartments at the rear end are too small, but a spacious galley is provided up front.

To the occasional passenger with an interest in the aircraft carrying him, the view from the window out over the wings will be unusual. The wing itself is so thick (T/C ratio 18 per cent constant) and of such aspect ratio as to appear humped, thus accentuating the smallness of diameter of the pencil-like Mambas. At the rear, the trailing edge is seen to be cusped and the Mamba jet pipes, naked and unfaired, seem to pop out like afterthoughts.

A glance from any window at this juncture of the flight showed the aircraft to be sailing above 10/10ths cloud—in a north-easterly direction, according to sun and time. The Lancaster was still nearby, although it was not easy to see at its slightly higher level: the windows of the cockpit, from which it was now observed, are so positioned as to give a good view all round and downwards but a somewhat restricted one upwards.

No stalls were attempted on the flight, but Franklin reports that warning and recovery are quite satisfactory.

A radio bearing for home and a rapid descent through cloud, throttled back and with reverse-torque lights blinking, torquemeters reading near zero and fine-pitch-stop lights on (below 27 deg pitch) brought the Apollo back into its base circuit in a very short time. One could not help thinking that when braking airscrews are fitted and if the warning lights for these (already provided for) are on together with all the others, the Apollo cockpit will shame a Christmas tree.

At 30 kt on the circuit, flaps were lowered to take-off position and the wheels went down with a resounding clunk. Appropriate trimming followed and now there were the little green undercarriage-warning lights shining. The approach was commenced at 115 kt and 11,200 r.p.m., full flap being dropped at this speed. Over the hedge the needle read 90 kt and the attitude of the aircraft was quite nose-down, giving a very good view of the field ahead. At 80 kt the wheels touched down, the r.p.m. dropped to 8,000, the pitch-stops were withdrawn, and after a few hundred yards the reassuring power of the brakes was felt.

If it is necessary to go round again, it is quite in order to open straight up from 10,000 r.p.m., which is convenient for the approach, but at lower r.p.m. a little time is needed for acceleration. Various power-lever settings are marked on the quadrants, but they are likely to be altered in name and position in the near future.

Development of the prototype Apollo will continue as quickly as possible, and a second machine is under construction. No firm orders have been announced, but enquiries from many countries, particularly European and South American, are likely to lead to orders for as many as fifty of these 24/40-seat aircraft.

ARMSTRONG WHITWORTH APOLLO DATA.

Four Armstrong Siddeley Mambas.

Span	92ft (28.00 m)
Length	71ft 11in (21.90 m)
Overall height	26ft (7.9 m)
Undercarriage track	17ft. (5.18m)
Gross wing area	986 sq ft (91.6 sq m)
Aspect ratio	8.58
Fuel capacity (max)	990 gall (4,500 litres)
Normal take-off weight	43,000 lb (19,500 kg)
Max payload	10,000 lb (4,536 kg)
Take-off power	4,040 s.h.p. + 1,228 lb static thrust (1,024 c.v. + 139 kg x 4)
Normal power loading at take-off	8.1 lb/h.p. (3.62 kg/c.v.)
Max speed at 20,000ft	341 m.p.h (549 km/hr)
Economical cruising speed	276 m.p.h. (445 km/hr.)
Cruising range (still air) at 10,000ft	1,100 miles (1,770 km)
Cruising range (still air) at 20,000ft	1,400 miles (2,250 km)
Stalling speed	88 m.p.h.
Service ceiling	32,500ft (10,200 m)
Take-off run	1,100yd (1 000 m)

HERE and THERE

P.1040s—They're Lovely!

"HAWKERS, ice-cream men and fruit sellers gave the display a Hampstead-Heath-on-a-Bank-Holiday atmosphere."—From a Sunday newspaper's report on the first public day of the S.B.A.C. Show.

Turkish Visit

IT is announced that the visit to Turkey by 12 Vampires of No. 32 Squadron, based on Nicosia, Cyprus, will take place from September 21st-28th. The tour was to have been made last month, but was postponed, due to the accident in which A. Cdre. G. Bartholomew, the British Air Attaché in Ankara, was killed.

Aero Golfers' Meeting

THE autumn meeting of the Aero Golfing Society, of which Lord Brabazon and Sir Frederick Handley Page are, respectively, president and vice-president, will be held at the Richmond Golf Club, Sudbrooke Park, Petersham, Surrey, next Tuesday, September 20th, commencing at 10 a.m. The date of the Society's annual dinner has been provisionally fixed as December 14th.

Demonstrator's Dinner

TEST pilots missed an excellent opportunity of getting together socially when the Empress Club, London, entertained the Farnborough contingent on Saturday, September 10th. Exertions of the previous week and the prospect of a final performance the following day must have been a deterrent to many, since only a small proportion of those who took part in the S.B.A.C. Display accepted the Club's hospitality. Pilots normally have little opportunity of talking over their many problems, especially with such an authority as Sir Frank Whittle, who was the guest of honour on this occasion.

ANTARCTIC AUSTER: Shown at a recent demonstration at Beaumaris, Anglesey, is an Auster 5 2/3-seat floatplane (convertible to wheels or skis) which may be used in the rescue of 11 scientists marooned in the Antarctic. Similar aircraft will equip the expedition to Queen Maud Land next November.

New Leaf?

SEVERAL former leading pilots of the Luftwaffe—including one credited with 102 victories—are reported to be employed by the Argentine Government on various duties which include training the air force and flying aircraft to spray ground infested by locusts. It is said that a number of these Germans have escaped from Allied prison camps.

G!

IN the jet aircraft division of the Thompson Trophy race, held at Cleveland on September 5th, Captain B. Cunningham of the U.S.A.F., flying an F-86 Sabre, is reported to have completed the ninth lap of the 15-mile circuit at an average speed of 635.4 m.p.h. Fuel shortage on the tenth and final lap reduced his average for the course to 586.173 m.p.h.—in itself a remarkable performance for a closed-circuit race.

NEW SPEEDBIRD: The first Boeing Stratocruiser to be shown with B.O.A.C. markings. Delivery of ten Stratocruisers ordered by the Corporation will begin shortly, and they are expected to be in service on the North Atlantic route within a few months. Four of the Stratocruisers were originally ordered by Scandinavian Airlines.

BRITAIN'S GREATEST AIRCRAFT

DURING the past weeks much has been talked and written about the Bristol Brabazon. Thousands of people around Bristol, Farnborough and elsewhere, have been fortunate enough to see it; but the full record of its conception, its development, and its structural features and equipment has yet to be revealed.

On Thursday, September 29th, in a special gravure supplement, this absorbing story will be presented to readers of FLIGHT. The Brabazon's power installations, airframe structure and equipment will be described and illustrated in detail; and the projected features of its successor, the Brabazon II, will be reviewed.

It is advisable to order copies of this issue of FLIGHT in good time.

Mr. A. H. Hall

IT is with regret that we record the death at Farnham last Saturday of Mr. Arthur Henry Hall, who was chief superintendent at the R.A.E., Farnborough, from 1928 until his retirement in 1941. Mr. Hall, who was 73, was director of mine and torpedo production at the Admiralty from 1917 to 1919, also spending two years in charge of airship production at Cardington before going to the R.A.E. During the war years he was a consultant to the Ministry of Aircraft Production.

Formidable Giant

THE recent investigation into U.S.A.F. orders for the Convair B-36 bomber revealed some remarkable performance figures for this enormous bomber. First fitted with four J-35 turbojets in addition to its six 3,500 h.p. Wasp Major piston engines, the prototype B-36D now has four J-47 turbojets (5,200 lb thrust) to provide extra urge. This version, of which 130 are on order, is stated to have reached a top speed of 435 m.p.h. at 50,000ft. In addition, a standard B-36 H

HERE AND THERE . . .

type has flown 6,000 miles above 40,000ft at an average speed of over 300 m.p.h.

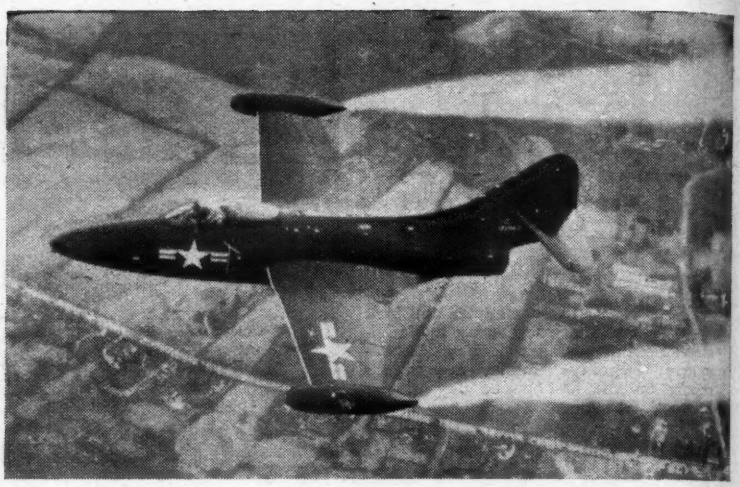
. . . and a Prayer

ONE of the four 2,100 h.p. Wright Duplex-Cyclones of a U.S. Navy Martin Mars dropped into the Pacific while the flying boat was on its way from California to Hawaii recently. Despite the loss of power, the aircraft was reported to have completed its flight successfully.

FORTY YEARS BACK

"By way of adding to the attractions of their Exhibition, the authorities at Nancy made a lucrative offer to M. Sommer to carry out some flights. On Monday the weather was against flying. . . . A commotion ensued upon the announcement that M. Sommer would not fly. Some of the crowd threatened to break down the sheds and fences, but M. Sommer generously came to the rescue of the authorities. A lull in the wind provided a chance of flight, of which he took instant advantage, flying once round the ground, and thus the spectators were appeased and retired in orderly fashion.—*From "Flight" of Sept. 11th, 1909.*

ULTRA-LIGHT: Lord Ventry, the leading British airship expert, inspects a Goodyear blimp during a study of current American airship manufacturing and operating technique. He has an airship under construction in Britain.



FOR EMERGENCY USE ONLY: This Grumman F9F Panther of the U.S. Navy is demonstrating the latest development in external fuel tanks, by which, when extra performance is required, the contents only are jettisoned instead of the complete tank. At 200 m.p.h., kerosene contained in the wing-tip tanks is released in 40 seconds through an electrically operated valve, and vapourizes before reaching the ground.

Mamba-Dak

A DAKOTA fitted with two Armstrong Siddeley Mamba engines flew for the first time on Saturday, September 3rd, at Bitteswell airfield, near Rugby, and has since then made regular development flights. The purpose of the tests is to add to the great deal of flight experience already obtained with Mamba turbo-props and also to show how this type of unit can enhance the performance of very well established aircraft.

Northern Appointments

BLACKBURN AND GENERAL AIRCRAFT, LTD., have announced the appointment of Mr. H. ("Timber") Wood as their chief test pilot. The appointment follows the merger, last January, of the Blackburn Aircraft and General Aircraft companies. Mr. Wood was chief test pilot to the latter firm for six years, and will almost certainly be in charge of flight trials of the Universal freighter, now nearing completion at Brough.

The status of Peter Lawrence, chief Blackburn test pilot before the amalgamation, is now obscure, but he will no doubt test any Blackburn-designed prototypes which may emerge in the near future. Another recent appointment to the combined organization was that of Mr. M. G. K. Bryne as public relations officer. His predecessor, Mr. C. G. Hollowell, is now P.R.O. to Short Brothers at Belfast.

America's Loss

DEEP and widespread regret was occasioned by the news, on Monday, September 5th, that Captain Bill Odom, the American pilot, had lost his life while flying an F-51 Mustang in the second lap of the Thompson Trophy race at Cleveland, Ohio.

Odom, who was 30, had made a number of notable flights, of which the two best remembered are his 1947 round-the-world dash in a converted A-26 Invader, which took 73 hr 5 min and, last March, his 4,957 record-breaking non-stop solo flight from Honolulu to New Jersey in a Beechcraft Bonanza.

The winner of the race in which Odom crashed was C. Cleland, a Naval fighter pilot, who flew his Corsair round the course at 397 m.p.h. An F-80 Shooting Star won the Allison Jet Trophy for W. C. Rew (his speed was 594.8 m.p.h.), and Bill Brennand, at 177 m.p.h., was first in the Goodyear Trophy Race for midget aircraft.

"Quickie"

DEVELOPMENT of the Ministry of Supply's supersonic rocket—a pre-eminent exhibit on the Ministry's Farnborough stand—is featured in the short film which comprises the Central Office of Information release for October. Entitled *Faster than Sound* it will be given a free showing at hundreds of British cinemas.

Fast-flying Dutchman

A PERFORMANCE of 592 m.p.h. in a Gloster Meteor 4 by Maj. Jan Flinterman of the Royal Netherlands Air Force has been submitted to the F.A.I. for homologation as a Netherlands national speed record. Maj. Flinterman, who is C.O. of No. 323 Squadron, has also claimed the Dutch altitude record with a flight to 47,572ft in a Meteor.

NEWS IN BRIEF

A RECENT new British Standard specification (B.S. 1486: 1949 Pt. 3) covers small light-alloy lubricating nipples as used in aircraft.

* * *

The first of 60 Gloster Meteors on order are expected to arrive in Denmark at the end of this month. Danish pilots have already received training from the R.A.F. in handling the aircraft.

* * *

Mr. H. K. Jones, formerly of Hawker Siddeley, is shortly leaving Cape Town for New Zealand, where he will be staying for six months: his address there will be c/o National Bank of New Zealand, Wellington.

COMMEMORATION

This Week's Battle of Britain Ceremonies : R.A.F. Stations Open : The London Fly-past

NEXT Saturday, September 17th, again provides members of the public with the opportunity of making close acquaintance with the activities of R.A.F. stations nearest their homes. In all, 82 stations—listed below—will be "at home" and flying displays will be put on at the majority. Space forbids any attempt at summarizing the programmes planned at each airfield, but normally, the everyday activities of a station will form the focal point of its exhibitions—both static and flying. In addition, Bomber and Fighter Commands will provide "circus" formations of representative aircraft to put in an appearance in areas where Meteors, Vampires, Lincolns and Lancasters are not frequently seen. Whichever station they may visit, members of the public are assured of an excellent and varied day's entertainment.

The now customary opening of R.A.F. stations to the public is, of course, but a part of the celebrations and ceremonies which are being held this week to commemorate the ninth anniversary of the Battle of Britain. A second outstanding event is the fly-past of more than 250 aircraft which is due to take place over London to-day, Thursday. Smaller formations are to fly over many other parts of the country during the day. The main stream will be led by a single Hurricane, and the following formations will consist of 66 Meteors, 41 Mosquitoes, 30 Lincolns, 24 Lancasters, 18 Vampires, 18 Hornets, 18 Spitfires, five Hastings, eight Sea Furies, four Sea Hornets and ten B-50s.

Static displays of aircraft and vehicles are being held on the Horse Guards Parade, in Hyde Park and in Regents Park, and H.M. Air Force Vessel *Bridlington*, a Sunderland flying boat and a R.A.F. tender are moored on the Thames near the Tower of London. The week is concluded by the usual Service of Thanksgiving in Westminster Abbey at 3 p.m. next Sunday, when the address will be given by Canon Charles Smyth. Detachments representing all the Services which fought in the Battle in the air and on the ground will be present; and, after the Service, Marshal of the R.A.F. Lord Tedder will lay a wreath on the R.A.F. Memorial.

In addition to the "open" stations in the following list, London Airport visitors' enclosure will have a programme of attractions organized by the Feltham branch of the R.A.F.A., and Service aircraft will take a temporary place among the usual civil types seen at the Airport.

R.A.F. Stations Open to Public

COUNTY	R.A.F. STATION
Aberdeenshire	Dyce
Anglesey	Valley
Antrim, N. Ireland	Aldergrove (Belfast)
Bedfordshire	Cardington (Bedford), Henlow (Hitchin)
Berkshire	Abingdon (Oxford)
Buckinghamshire	Booker (Bomber Command H.Q. "At Home"), Halton (Aylesbury)
Cambridgeshire	Waterbeach (Cambridge)
Carmarthenshire	Pembrey (Llanelly)
Cheshire	Sealand (Chester)
Cornwall	St. Eval (Newquay)
Cumberland	Silloth
Devonshire	Mount Batten (Plymouth), Chivenor
Essex	Debden (The R.A.F. Empire Radio School) (Saffron Walden), Chigwell, Hornchurch (Romford and Hornchurch), North Weald
Fifeshire	Leuchars (Dundee)
Glamorganshire	St. Athan (Cardiff)
Gloucestershire	Filton, Little Rissington (Cheltenham), Aston Down, South Cerney (Cirencester)
Hampshire	Odiham (Basingstoke), Thorney Island (Portsmouth), Beaulieu, Andover (Andover)
Huntingdonshire	Upwood (Peterborough), Wyton (Huntingdon)
Kent	West Malling (Maidstone), Manston (Margate, Ramsgate, Broadstairs), Biggin Hill, Hawkinge (The W.R.A.F. Depot), (Folkestone)
Lancashire	Ringway, Woodvale, Kirkham (Preston), Weeton (Blackpool)
Lincolnshire	Cranwell (The R.A.F. College) (Sleaford), Manby (Louth), Binbrook (Grimsby), Coningsby (Boston), Hemswell (Gainsborough), Scampton
London	Hendon (Hendon)
Midlothian	Turnhouse
Middlesex	Northwood
Morayshire	Kinloss (Elgin, Forres and Nairn)
Norfolk	Horsham St. Faith (Norwich), Feltwell (Thetford), Swanton Morley (East Dereham), Watton
Northampton	Wittering (Stamford)
Northumberland	Acklington (Newcastle-on-Tyne), Ouston
Nottinghamshire	Syerston (Newark), Newton
Oxfordshire	Benson (Reading), Upper Heyford (Banbury)
Pembrokeshire	Pembroke Dock
Perthshire	Perth
Rutland	Cottesmore (Oakham)
Shropshire	Ternhill (Newcastle-under-Lyme), Shawbury (Shrewsbury)
Somerset	Locking (Weston-super-Mare)
Staffordshire	Cosford (Wolverhampton), Lichfield
Suffolk	Felixstowe, Mildenhall
Warwickshire	Castle Bromwich (Birmingham)
Wigtownshire	Wig Bay
Wiltshire	Melksham (Melksham), Colerne (Bath), Hullavington (Chippenham)
Yorkshire	Church Fenton (Leeds), Linton-on-Ouse (York), Finningley (Doncaster), Middleton St. George (Darlington), Catterick (Richmond), Leconfield (Kingston-upon-Hull and Beverley), Dishforth (Harrogate)

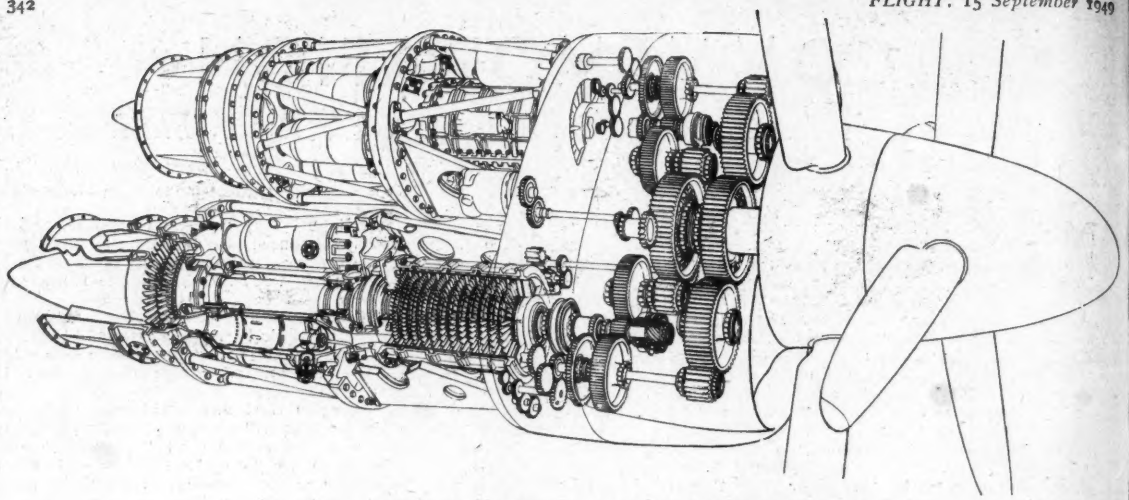
FIFTH R.A.F.A. FESTIVAL

THE Albert Hall, London, was twice nearly filled on Sunday last at the afternoon and evening performances of the Royal Air Force Association's Festival of Remembrance. Massed bands of the R.A.F. were in attendance, together with the R.A.F. and W.R.A.F. choirs. W/C. A. E. Sims conducted and Cyril Gell was at the organ.

Before the Commemoration Service began, there was a concert given largely by ex-members of the R.A.F., and there were also displays by the R.A.F. physical training display team, the W.R.A.F. band, the R.A.F. Regiment, the W.R.A.F. physical training display team, and the Halton Apprentices drum and pipe band. All were extremely good and it would be difficult to pick out any one item for special praise, but the R.A.F. physical training team was exceptional.

A feature of the evening was the performance by the massed bands of Patrick Barrow's "In Memoriam." This was written as a tribute to those who did not return from operations and was actually composed during the war in an operations room on a Yorkshire airfield.

The assembly of the various forces, the entry of the R.A.F.A. standard-bearers and the service which followed was most impressive, reaching a climax as Barbara Sumner, with the massed bands and choirs, sang the anthem "The Holy City." The Rev. Leslie Wright conducted the service.



COUPLED NAIAD

New Information on Napier's Latest Turboprop

ALTHOUGH the existence of a design for coupling a pair of Napier Naiad axial-flow turboprops had been announced, it was not until recently that preliminary details became available. From the accompanying drawing and the photograph of the model on page 354 it will be seen that the two turboprops are anchored side by side to a gear-box through which they drive centrally disposed counter-rotating airscrews. The gear box houses a two-stage reduction gearing and incorporates the air intake ducts to lead air from the ducted spinner—a feature also of the single Naiad—to the two compressors.

Airscrew loads are distributed evenly between the two engines with the aid of twin free-wheel mechanisms and muff-type couplings incorporated in the reduction gearing. The gear box was, in fact, designed and developed as an individual unit and has successfully completed acceptance tests. It is built up of light-alloy casings, and the drive shafts of the two gas turbines extend into the gear box. The muff-type couplings to which reference was made above provide flexibility to accommodate slight deflection and thermal expansion, and the free-wheel unit comprises a driving and driven claw which engage when the engines gain self-sustaining speed. Similarly they disengage either when the engines are stopped or when they are made to do so by the use of the manual control.

Either of the two turbines can be operated separately, and the individual accessories of both are grouped around the compressors within the diameter of the common gear box. The two Naiads of the coupled unit are identical as are the control and lubrication systems. Both are supplied with oil from a reservoir formed in the gear box casing and serving also the airscrew governor unit. The control of each power unit is by means of a single lever in the normal manner for gas turbines, and both engines have their own electric starting systems. Such is the method of assembly of the Coupled Naiad that any one section can be dismantled without undue disturbance of the other. The complete unit is mounted by the central main support plate of each individual Naiad.

NAPIER COUPLED NAIAD

Rating (sea level static)	r.p.m.	b.h.p.	Net Jet Thrust (lb)	Fuel Cons. (gal/hr)
Max. take-off (I.C.A.N.)	18,250	2,970	482	258
Max. take-off (tropical)	18,250	2,362	408	225
Normal climb	17,500	2,273	408	214
Max. cont. cruising	17,000	1,936	364	192
Max. cont. cruising (one turbine cut out)	17,000	953	182	96

ARMSTRONG SIDDELEY POWER FIGURES

SOME new performance figures for Armstrong Siddeley piston and gas-turbine power units were announced last week. Those for the Cheetahs 17 and 27 differ only very slightly from those for the 15 and 25, but the ratings for the Adder turbojet, which is similar in many design features to the Mamba turboprop, are newly released.

ARMSTRONG SIDDELEY CHEETAH 17 AND 27

Rating	r.p.m.	Height (ft)	b.h.p	Fuel Cons. (gal/hr)
Take-off	2,550/2,700	S.L.	420/475	40/44
Max. climb	2,300	S.L.	370	32
Combat	2,425	4,000	400	35
Max. w.m. cruising... ...	2,100	7,000	280	19

ARMSTRONG SIDDELEY ADDER

Rating	Height (ft)	r.p.m.	Speed (m.p.h.)	Net Thrust (lb)	Fuel Cons. (lb/lb/hr)
Emerg. and take-off ...	S.L.	15,000	0	1,100	1.02
Max. climb	S.L.	15,000	300	960	1.23
Max. continuous ...	S.L.	14,250	400	740	1.29
Max. continuous ...	30,000	14,250	400	370	1.20

THE HOOK HYDROFIN

A RECENT reference to the marine craft known as the Hook Hydrofin may have given a misleading impression of the principle on which it operates. As Mr. Christopher Hook, its inventor, points out, the main hydrofoils upon which the craft is supported do not plane on the water surface, but run at an approximately constant depth below it. The efficiency of a planing hull, he says, is indicated by its L/D ratio which, in a good design, is about 6; on the other hand, a hydrofoil working *under water*, with lift on its upper and lower surfaces, can show L/D ratios as high as 20; and complete craft, with the hydrofoils mounted on struts, can give a figure of 10, which is comparable with that for modern aircraft. As the hydrofoils do not plane, the craft is not subjected to buffeting or pounding.

The Hook Hydrofin—which figured in a hydrofoil research programme at the Royal Aircraft Establishment—was described in detail in an article in *Flight* of November 11th, 1948.

FLIGHT AND CIVILIZATION

"Interpretive History of Flight," by M. J. B. Davy, F.R.Ae.S. His Majesty's Stationery Office; price 8s 6d.

THIS new edition of the *Interpretive History of Flight*, written by the Keeper of the National Aeronautical Collection at the Science Museum, surveys briefly the whole history of aviation from its origins in nature and legendary beginnings to the present day. It is, however, no mere catalogue of events; it is also a fascinating commentary on the influence of those events on human relationships through the ages. For, as Mr. Davy explains, "It cannot be fruitful to consider [historical] developments without some regard for the motives which inspired them and the changes, social and economic, which they brought about."

Since the first edition of *Interpretive History* was published in 1937, it has been accepted as a standard brief reference work on aeronautics. In its new form, revised and brought up to date with a chapter on the use and implications of air power in the Second World War, it is even more interesting, accurate, and very good value for its modest cost.

THE FARNBOROUGH STORY

Britain's Newest Aircraft and Engines Brilliantly Demonstrated

Illustrated with "Flight" photographs

IN the pages which follow are impressions, by members of *Flight's* staff, of the S.B.A.C. Flying Display. It is not the intention here to give detailed particulars of the aircraft—that aspect was fully dealt with in our pages last week—but rather to present the results of personal studies of their appearance, equipment and general appeal, together with impressions of their individual showings in the hands of their demonstrating pilots.

At the same time, and as most readers will be aware, several extraordinarily interesting new aircraft were taken off the secret list at the last moment in order that they might be publicly demonstrated: previously no word had been permitted concerning them, so we take this opportunity of revealing such of their features as may now be mentioned and illustrated.

As we have implied, this account is in no sense a show catalogue; aircraft have been grouped in categories, and arranged alphabetically within those divisions, for ease of reference.

Fighters (Including Strike and Reconnaissance Types)

D.H. 113 NIGHT FIGHTER. Mr. Pike left no doubt that adaptation of the Vampire as a two-seat night fighter has been effected without prejudice to inherent flying qualities. Compared with present piston-engined night fighters, of which the Mosquito Mk. 38 may be taken as representative, the new machine is claimed to afford about 8,000ft more ceiling and 130 m.p.h. extra speed, averaged over a band of heights. The prototype displayed had completed some ten hours of flying before its Farnborough appearance, and was looped, rolled and flown round in fast, tight circuits with obvious confidence. In its bizarre camouflage and with its aggressively tilted and lengthened nose, the "113" made a deep impression, not the least on those who have anxiously awaited the advent of Britain's first jet-propelled night fighter.

The roof of the lengthened canopy, beneath which pilot and radar operator have staggered seats, is hinged at the rear. Of unsymmetrical design, the windscreen embodies a clear-vision panel in the port front corner.

D.H. SEA HORNET P.R.22. Third, and latest, naval version of the world's fastest piston-engined twin, a Sea Hornet 22 commanded attention. Primarily intended for photo-reconnaissance, this model can also deliver bombs or rockets. For day reconnaissance two F.52 cameras are fitted, and for night photography one Fairchild K.19B.

D.H. VENOM F.B.1.—To describe it briefly, the new de Havilland Venom F.B.1 fighter bomber (D.H. Type 112), which first flew on September 2nd, has a Vampire nacelle, adapted (without enlarging the diameter) for the Ghost turbojet in place of the Goblin; standard booms and tail unit; and a thin-section square-tipped wing, with moderate leading-edge sweep-back. Thus, it is superior to all marks of Goblin-powered Vampire in attainable Mach number, climb and ceiling. The new wing appears to have detracted in no way from the sweetness of handling associated with the Vampire, and, as reported last week, John Derry did two rolls at low level on the very first flight.

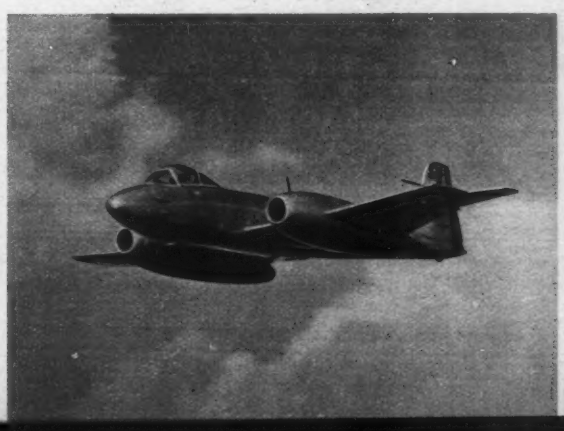
Auxiliary fuel tanks are tip-mounted, but, not yet having been cleared for aerobatics, were detached before Derry's series of demonstrations. These were remarkable, not only for the confidence exhibited by the pilot in what, despite the very extensive use of standard components, must be regarded as a new type, but for the intimacy of the whole performance. In many respects, it was reminiscent of Derry's unexcelled display at Farnborough last year on one of the then-new Vampire 5s. Upward rolls, half rolls, Derry's own brand of "inverted reverses," and low inverted runs, were all included in the Venom's "premiere."

GLOSTER METEOR F.8. Some slight apprehension had been expressed by the redoubtable Zurakowski that, with normal 7,000-lb "urge" from the Rolls-Royce Derwents of his mount—one of the new Meteor F.8s for the R.A.F.—his demonstration might suffer somewhat in comparison with the performances of the "reheaters." In point of fact, his near-vertical climbs in this standard fighter were sustained for an astonishing length of time. Quite unique was a spin—a favourite manœuvre of "Zura's"; his flick-rolls were a joy, and his deliberate use of ailerons, almost to the point of touch-down, a piece of first-rate showmanship.

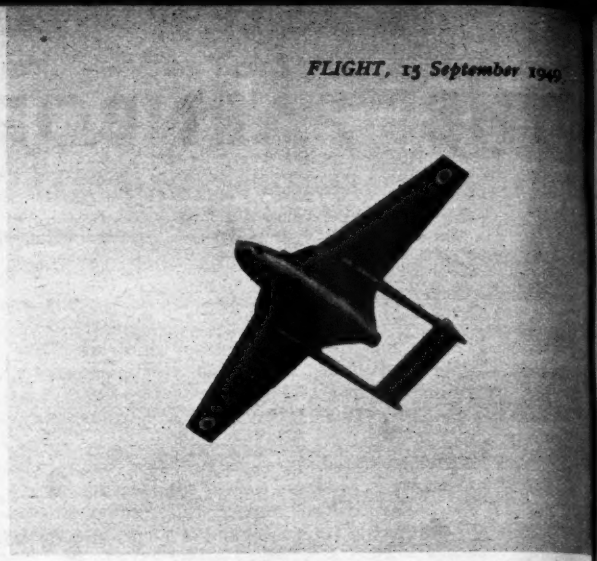
HAWKER N.7/46. This type—the "Hawker Naval Fighter," as it was billed—was flying with repositioned arrester hook and with other naval fitments, including provision for rocket-assisted take-off. Its wings were unfolded only a few moments before Neville Duke took off for his sequence of extremely accurate and well-placed manœuvres, of which large-radius loops, low inverted runs, and late pull-outs from steep dives were the most striking. It may now be disclosed that provision is made on this type of fighter

The Python-powered Westland Wyvern makes its mark.

Gloster's Mk. 8 Meteor on its first public appearance.



The 600-m.p.h. Hawker N.7/46, presented by Neville Duke.



John Derry shows how the Venom's outline differs from the Vampire's.

THE FARNBOROUGH STORY . . .

for auxiliary fuel tanks to be mounted near the junctions of the mainplanes with the wing-root intakes for the Rolls-Royce Nene turbojet.

HAWKER P.1052.—Confirmation was to be had that the fuel tankage of this research fighter is the same as that of its predecessors, the P.1040 and N.7/46; that is to say, there are tanks immediately behind the cockpit, in the region of the jet-pipe bifurcation, and between the twin tail pipes. Thus, as the Hawker Company are not slow to point out, an abnormally long range is reconciled with extreme speed and notable climb performance, admirably illustrated by Trevor Wade's demonstration. On Wednesday this opened with a steep, protracted zoom in the inverted position, followed by what can truly be described as a breathtaking plunge through dense cloud towards the airfield—which, from the zenith of the zoom, must have appeared very much contracted.

The P.1052, in its latest Cellon finish, looked the acme of fighter efficiency. Wade's low rolls were much appreciated.

HAWKER SEA FURY F.B.11. Despite jet pre-eminence, no apology was needed, or made, for the presence of one of these sturdy Centaurus-powered fighter bombers. Under economical cruising conditions, with two 90-gall drop tanks, the range is more than 2,000 miles.

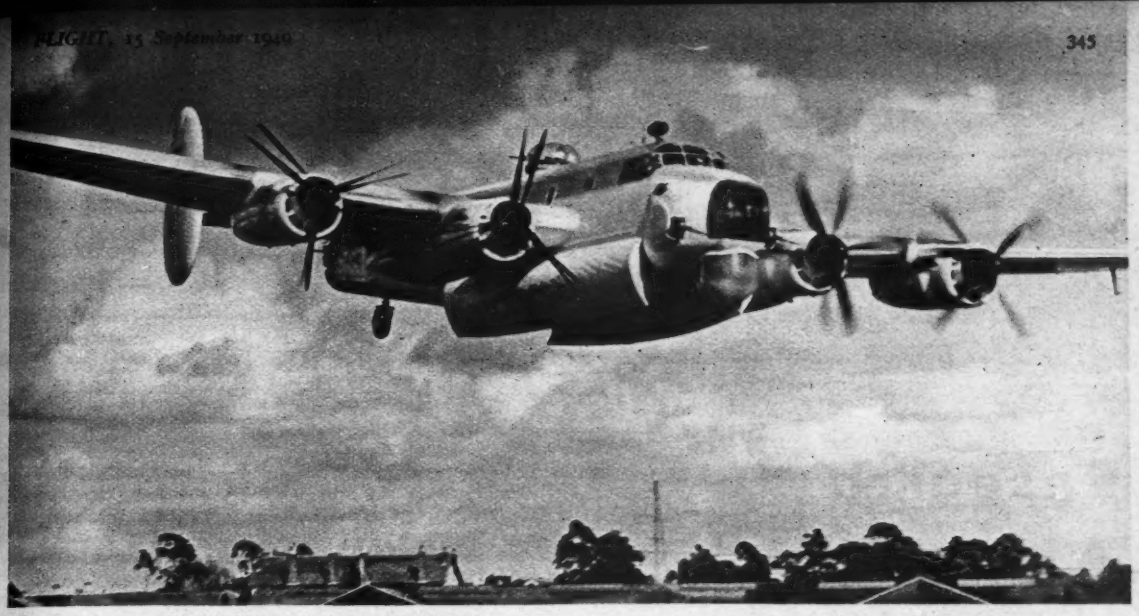
VICKERS-SUPERMARINE ATTACKER.—Though outstripped in performance by the "510," its lineal descendant, a standard Naval Attacker was flown by Mr. Colquhoun in thoroughly reassuring style. Colquhoun's specialities were successive rolls to port and starboard. Finished in the standard Naval colour scheme, the Attacker, when airborne, was indistinguishable from sleek models on the Vickers-Supermarine stand. The keener-eyed observers saw the lift-spoilers, forward of the flaps, in operation during the final approach and landing.

VICKERS-SUPERMARINE 510.—What was probably the fastest flying yet seen in Great Britain was only part of Michael Lithgow's offering in the Type 510 research fighter. Precise performance figures, in so far as they are known at this early stage of development, are not to be divulged, but more than one of our guests from abroad, with an eye for a fast aircraft, estimated the speed of the "510" on one of its low runs as over 1,050 km/hr (about 660 m.p.h.). Almost equally amazing was the rate of roll at very high speeds—of the order of 160-180 deg/sec. This is made possible by the Automotive Products Servodyne power-assisted ailerons, in conjunction with spring tabs.

With its ample wing area and relatively low weight (due in part to the normal tailwheel undercarriage), the "510" is reputed to handle extremely well at altitude. Reference was made in our preceding issue to the new "needle"

The rakish Supermarine 510 passes by at 600-650 m.p.h

Wares dispensed by the Sea Fury are conveniently displayed.



With yawning bomb-bay and two Griffons at rest, the Avro Shackleton is introduced by its demonstrator, Mr. Baker.

THE FARNBOROUGH STORY . . .

nose, which might benefit the air flow into the elephant-ear ducts for the Rolls-Royce Nene 2 turbojet.

WESTLAND WYVERN T.F.2.—The performance to be expected from a compact, though relatively heavy, single-seater, fitted with the world's most powerful production-type turboprop, was fully realized by the Wyvern T.F.2 in charge of Mr. Graves. A foretaste of the capabilities of the Wyvern had been afforded by earlier displays, where the Mk. 1, with Rolls-Royce Eagle 24-cylinder piston engine, had flown; but the installation of the 4,000 e.h.p. Python in the new variant has conferred a notably improved performance, derived not only from the increased power but from decreased drag.

Airborne from a rapid take-off, the Wyvern upward-rolled easily, flew inverted, and, in extremely tight turns within the airfield perimeter, scored the sky with wing-tip trails. Points noted in the viewing park, and on a large model, were the faired bifurcated jet pipes, emerging on each side of the fuselage below the cockpit and slightly aft of the pilot's seat, the thin 44ft laminar-flow wings which are folded to an overall width of 18ft, and the neat arrester-hook stowage. A fascinating spectacle during starting was the Rotol eight-blade contra-rotating airscrew. The Wyvern taxied out with wings folded; then, under hydraulic power, the main outer planes descended slowly into place, to be followed very rapidly by the tip portions.

Bombers

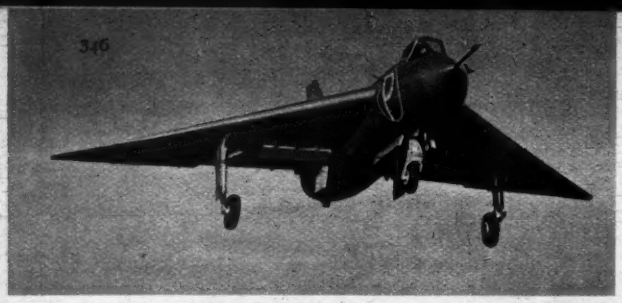
ENGLISH ELECTRIC CANBERRA B.1.—W/C. Beamont's introductory performance in our first jet bomber was historic. The initial climb, with the Avons roaring and rumbling far into the distance, would not have shamed a Meteor; then the beautiful medium bomber bore down fast along the runway and rolled away (one roll in each direction), its blue shape seeming, chameleon-like, to change its hue against the varicoloured clouds. A second run culminated in a perfect roll-off.

Beamont's show on Tuesday was well advanced when three or more objects were seen to detach themselves from the Canberra and fall swiftly; they proved to be portions of the automatic observer, torn from their mountings when the bomb doors were opened to reduce speed. No structural harm resulted, and Beamont immediately entered a series of extremely tight, slow turns. On Wednesday, with wheels and flaps extended, he rocked the machine by its ailerons at impressively low speed. A new aircraft has never been more convincingly demonstrated.

Invisible to onlookers, but scrutinizing test instruments behind the pilot's position, was Mr. Walker, an observer, for whom both envy and concern were felt as Beamont got into his aerobatic stride.

AVRO SHACKLETON G.R.1.—The largest aircraft on show (span 120ft), the Shackleton long-range maritime reconnaissance aircraft, is a specialist type which called for the most skilful demonstration technique. Mr. Baker succeeded in making a memorable event of what might easily have been a very ordinary display; this he achieved by the simple expedient of flying all-out at really low level, so that the size of the Shackleton could be truly appreciated and the armament positions disclosed. His run-in with two Griffons out of action and their de Havilland contraprops, with six blades apiece, at rest, was a sight to remember. The bomb bay, extending from the radome to a point well aft of the trailing edge, was agape, revealing its exceptional capacity. Those familiar with anti-submarine warfare appreciated especially the turning ability of the Shackleton.

The English Electric Canberra ascends arrow-like during Beamont's memorable performance.



Arrival of the Avro 707 delta-wing research aircraft.

The rebeat Vampire before pulling up in a boosted climb.

Research Aircraft

Shaped for speed.

AVRO 707.—Darkest of this year's "horses," this Derwent-powered research aircraft of delta form flew in from Boscombe Down on Tuesday evening for static exhibition. The pilot was Eric Esler, who made two circuits of wide radius and flew along the runway at some 600ft at 300-350 m.p.h. before entering his landing circuit. He made a long, straight, low approach and, from the head of the runway, was seen to vanish below trees before rumbling in for touch-down at what seemed to be something over 100 knots. The Avro 707 has a wing of equilateral triangular form, spanning 33ft; the length of the fuselage, in which the cockpit is well forward, is 30ft 6in. Far aft, towards the swept-back fin and rudder, are the intakes, unusually positioned in the top surface of the fuselage and divided on the centre line.

D.H. REHEAT VAMPIRE.—This Vampire adaptation represents an early step in de Havilland's reheat-development programme, but Mr. Beaumont showed that this step is an appreciable one. When reheating sets in, an appalling din (someone described it as "like tearing tarpaulin") blasts the ear drums, but quickly diminishes as the Vampire recedes aloft. One mused on the possibilities of a Venom with reheat to augment its Ghost-thrust. The reheat Vampire has a Mk. 5 wing but retains the old square-cut fin and rudder assemblies. Beneath these are skids to guard against impingement of the tailpipe on the runway.

GLOSTER AVON-METEOR.—The world's most powerful and fastest-climbing single-seater, this Rolls-Royce development aircraft, adapted for two of the still-secret axial Avons, rocketed up into the blue and plummeted down again with tremendous *élan*. Mr. Heyworth delighted everyone, especially those of our friends from abroad who have little opportunity to witness such performances, by turning off the high-pressure fuel cocks and streaming white paraffin trails in the best sky-writing manner. Particularly effective was this when the Meteor descended steeply and almost noiselessly, pulled out sharply and upward-rolled away before the Avons were relit.

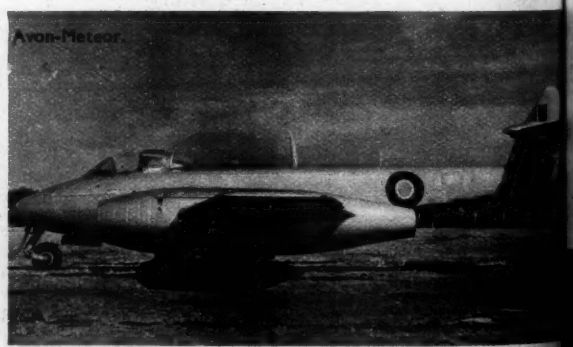
Fighter tacticians must have been impressed when, during a slow fly-past with wheels and flaps down, Heyworth suddenly retracted everything, opened up the Avons to full thrust and made a near-vertical exit from the arena.

GLOSTER REHEAT-DERWENT METEOR. — At previous S.B.A.C. displays Capt. Shepherd has been responsible for the heavyweight Nene-Lancastrian and Avon-Lancastrian "test-beds" which, technically interesting though they were, restricted the scope of his performance. This year his mount was one of the hottest of the "hot-stuff" single-seaters—a Rolls-Royce development Meteor fitted with reheat Derwents. Watching his moderate-speed fly-pasts, followed by the lighting-up of the reheaters, afforded the same thrill as schoolboys enjoy on obeying Mr. Brock's exhortation to "light the blue touch-paper and retire immediately." The Meteor thunderously ascended to high heaven, boring a clean hole through a cloud.

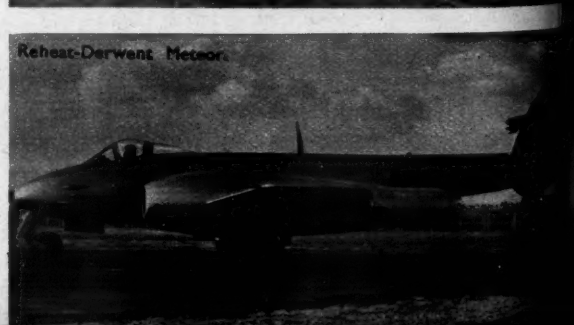
This aircraft is painfully noisy and smells offensively, but the sight of it "jumping to it" on the lighting of the reheaters, and receding sunwards until it becomes a mere pin-point of light, is something to remember.

AVRO PYTHON-LANCASTER. — A rate of climb of 4,000ft/min is attainable by this flying test bed, mounting a pair of 4,000 e.h.p. Armstrong Siddeley Python turboprops outboard of two Merlins. To comply with asymmetric-flying requirements only half of the output of the turboprops was tapped for take-off; even so, the black-and-white Lancaster scrambled nimbly to give zestful proof of its powers on Python-power alone.

Python-Lancaster.



Avon-Meteor.



Reheat-Derwent Meteor.

Trainers

AUSTER A.O.P.7.—Ranald Porteous handled this little dual-control A.C.P. trainer in a captivating manner. A low pull-out from a spin aligned the Auster perfectly for a sequence of loops, rolls and a "vertical reverse" manœuvre which baffled by its intricacy and delighted by its daintiness.

AVRO ATHENA 1 AND 2.—Though the Mamba-powered Athena 1 was not on parade, as had been hoped, a second Mk. 1, with Rolls-Royce Dart turboprop, and a Mk. 2 (Merlin) were both present and correct. The cowling of the Dart was removed for the edification of the many technicians who are keeping a close watch on all Athena developments. In the air Mr. Nelson proved that the Athena 1 is a worthy scion of an illustrious line of trainers.

BOULTON PAUL BALLIOL T.2.—A standard pre-production Merlin-engined Balliol of this series was presented in flight by Mr. Gunn. In the static exhibition, sections of the machine were used in conjunction with other mediums to illustrate how "planned design cuts servicing." A Balliol has satisfactorily completed its tropical trials and is now inscribed with the following itinerary: Flat 16, Grosvenor House, Boscombe Down, Istres, El Aouina, Castel Benito, Benina, El Adem, Fayid, Wadi Halfa, Khartoum, Malakal, Juba, Nairobi.

D.H. CHIPMUNK.—A complete Chipmunk, fully equipped to R.A.F. standards, made a very pretty showing in the static hangar, and a second—Mr. Fillingham up—looked even prettier in the air. It fairly leaped off the runway, and went through an aerobatic sequence in the precise, dainty manner which one expected of it.

GLOSTER METEOR T.7.—Aptly termed by the manufacturers "the shaft to the spearhead of Western Union defence," the 600-m.p.h., dual-control Meteor 7 trainer has been ordered for the air arms of Holland, Belgium and Denmark. A production model, in R.A.F. colours, was on view. In speed and general performance, the trainer duplicates, and even exceeds, the capabilities of the standard Mk.4, and the possibility that later models may acquire the new tail (and consequent aerodynamic advantages) of the Mk. 8 is to be expected.

HAWKER SEA FURY T.20.—An example of this fast piston-engined dual-control trainer remained static, together with the Fury single-seater fighter-bomber, but Fury performances at previous displays were remembered.

PERCIVAL PRENTICE.—The specimen of this trainer which had a place in the "light circus" was a Mk. 2, with supercharged Gipsy Queen. Similar machines are being supplied to the R.I.A.F. Mr. Weldon's demonstration left no doubt that India has chosen wisely, and that the Mk. 2 Prentice is a first-class aerobatic machine. His turns were exceptionally tight. Apart from slight cowling differences, the Mk. 2 is indistinguishable from the Mk. 1, as delivered in impressive quantities to the R.A.F.

VICKERS-ARMSTRONGS VARSITY T.1. There can be something rather pitiful in the sight of a bread-and-butter type of aircraft endeavouring to cut a dash in public; but this new crew-trainer for the R.A.F. certainly called for no apology in respect of performance. Taking full advantage of the new internally balanced ailerons, Mr. Bird gave everyone a close-up of the underslung bomb nacelle. Incidentally, the term "pannier" often applied to the structure is, surely, a misnomer.

Ground inspection disclosed parachute and crash exits fore and aft, and pull-in cabin windows. The "petal" cowlings of the two Hercules engines instantly appealed to the maintenance-minded.

Boulton Paul Balliol T.2 (Rolls-Royce Merlin).

Other Military Types

BRISTOL FREIGHTER (MILITARY VERSION). In the "heavy circus" Bristols were represented by a Military Freighter (New Type 170) with a typical load of a 40 mm Bofors gun, and a jeep as make-weight. If military attachés and others are not now convinced that this is the transport aircraft for their own air forces, it is certainly not the fault of the pilot, Mr. Howman.

FAIREY FIREFLY.—A standard Royal Naval Firefly 5, with radar nacelle and wing tank, and with Mr. Murphy at the controls, ran up its Griffon on the runway, rolled and gathered speed. There was a bang, a glow and a hiss of RATOG and the Firefly was kiting up steeply to gain height for a credibly fast low run. This was a simple and highly effective presentation of a very familiar and exceptionally popular aircraft.

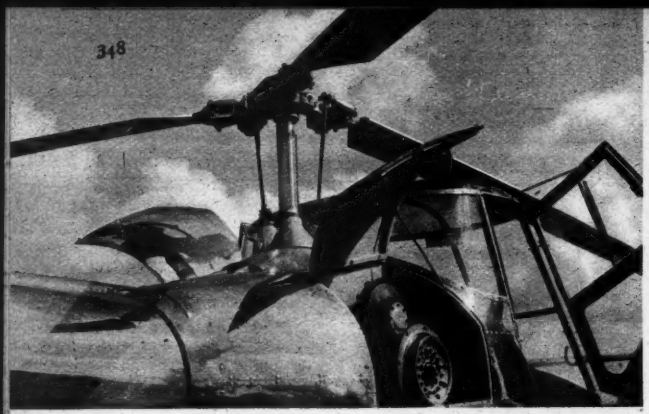
SHORT STURGEON T.T.2.—In target-towing form, as displayed, the Sturgeon is in production at Belfast for the Royal Navy. Stressed for accelerating and arresting, it will provide the Fleet with gunnery practice without recourse to short-based aid. Pilot, observer and radio operator are carried, and plotting equipment is installed.

VICKERS-ARMSTONGS VALETTA. The Valetta military transport was displaced from the flying display by its crew trainer derivative, the Varsity. Military authorities present were impressed by the adaptability of the Valetta, which functions impartially as trooper, freighter, paratrooper, glider tug, supply-dropper or ambulance.

VICKERS-SUPERMARINE SEAGULL.—This fast and handy Military amphibian, with contrapropped R.-R. Griffon and variable-incidence wing, got away smartly, whined past at more than twice the speed of the old Walrus, from which it is directly descended, zoomed steeply and landed—as becomes a machine designed for carrier operation—in a short distance. Mr. Morgan, the pilot, might have yearned for the "aerobatability" of his favourite Spitfire Trainer, but made the most of the Seagull's qualities.

Vickers-Armstrongs Varsity T.1 (2 Bristol Hercules).

Bristol Military Freighter (2 Bristol Hercules).



The new Mk. II Skeeter is a neat little all-metal side-by-side two-seater with dual control giving 95 m.p.h. on 145 h.p.

THE FARNBOROUGH STORY . . .

Helicopters

IN the light of the progress made by this country in the rotary-wing field of aviation during the past few years, it must be considered unfortunate that circumstances made it impossible for two of our more interesting designs to be seen at the display. In the case of both aircraft—the Bristol 171 and the Fairey Gyrodyne—development work is proceeding and there is little doubt that each will continue in the future to demonstrate even more emphatically the excellence of its individual and specialist qualities.

THE CIERVA AIR HORSE, which has now done nearly 30 hours' flying, evoked great interest; although, as was only to be expected, it was not disported by Alan Marsh with the fascinating agility displayed by the smaller types, it was by contrast exceedingly impressive in its manifest ability to lift bulky, heavy loads with ease. The aircraft shown was flying with enlarged fins, which, however, are not a final modification but merely a phase of the current test programme; incidentally, the 41-mile flight from Eastleigh to Farnborough was done in 35 minutes.

The Cierva Skeeter I was displayed by Basil Arkell in almost absurd contrast to the Air Horse, but it is to be superseded by the Mark II version which embodies a considerable amount of re-design. It is a delightfully neat all-metal aircraft providing dual control with side-by-side seating in a compact, chubby little body which also houses the Gipsy Major 10 engine athwartships. A spur-and-bevel reduction gear gives drive to the main rotor shaft, and the swash-plate is housed inside the body with tie rods rising to the hub linkages. The main rotor blades have ply surfaces on a metal spar, but the blades of the tail rotor are of all-metal construction.

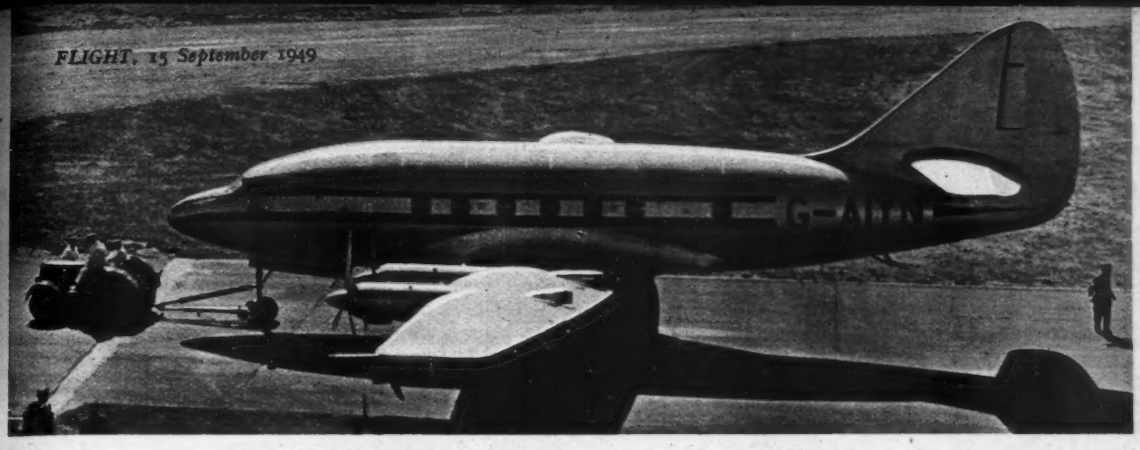
Given the designation W. 11 T was another extremely interesting exhibit by the Cierva Company, albeit only in model form—an enlarged twin-engined variation on the Air Horse theme in which, however, some considerable alteration in layout is apparent. The twin rear rotors are carried on faired booms at right angles to the fuselage axis and the engines are at extremities of short, high-level, stub wings. Merlin 502 engines are specified and these would employ annular radiators and cooling fans, but an alternative possibility is the installation of a pair of the smaller turbo-props of equivalent power used, possibly, with subsidiary conventional airscrews. The empty weight is given as 15,350 lb and the disposable load as 9,650 lb; cabin volume is 1,200 cu ft as against the 800 cu ft provided in the Air Horse, and on 320 gallons of fuel, the range is given as 440 miles at 128 m.p.h.

THE WESTLAND SIKORSKY S. 51 was handsomely flown by Lt. Reid and gave ample evidence of its versatility. The Royal Navy have ordered a batch of these helicopters and one is already undergoing Naval handling trials. An order has also been received from the Egyptian Government. Altogether, the British-built S. 51s have now completed about 1,000 hours of flying.

Two of these aircraft have been delivered to Pest Control Ltd., and the Mark II Spraycopter was also on view in the aircraft park. The first version of this machine employed an auxiliary pumping engine for dispensing the insecticide, and had the spray bars mounted on each side of the nose; in the latest form, spray pressure is provided by a set of compressed air bottles carried on an outrigger in front of the nose, whilst the spray bars have been moved farther aft and project on each side from the tail-boom root. The 85-gallon spray tanks are, as before, housed beneath the fuselage belly.

The Cierva Air Horse shows its characteristic long-travel undercarriage and the plan-form of its capacious fuselage.

Designed especially for crop-spraying, the Mk. II Pest Control Westland-Sikorsky S-51 is invoking interest among agriculturists.



The Apollo being towed from the air park in preparation for the flying display.

Civil

AIRSPEED AMBASSADOR.—No newcomer to Farnborough, the Ambassador joined in a "circus" fly-past. The second prototype was on show, furnished to accommodate 36 passengers in supreme comfort—there is ample leg-room and space for movement about the cabin. Those for the Corporation, as they will be employed on high-density short hauls, will be furnished to seat 49 passengers. B.E.A. red is becoming to the Ambassador, both as an exterior decoration and for interior trimmings. Full use was made of the reversible-pitch airscrews to demonstrate a short landing, and Mr. G. B. S. Errington finally reversed off the runway.

A.W. APOLLO.—Making its first visit to Farnborough, the Apollo fills a gap in the airliner class between the feeder-liners and the 30/50-seater medium-range transports. Take-off and climb performance are such as to permit operation into restricted airfields, and the range with up to 30 passengers will be highly suitable for some routes. In the air the large-diameter fuselage throws into contrast the small frontal area of the four A.W. Mamba turboprops. Mr. Franklin attempted nothing sensational, but showed the Apollo's manœvrability with both starboard engines feathered.

AUSTER AUTOCAR.—The newest Auster, which was known until Wednesday as the J/5B, must have appealed to many visitors. Designed for sale at low initial cost (mentioned as £1,575 provisionally) and for economical running, it is certainly Britain's most inexpensive genuine four-seater. In general appearance it is a typical Auster design with a slightly deeper fuselage than the Autocrat, from which it has been directly developed. Economy in operation is assisted by the use of the Gipsy Major I, which has a 1,500-hr overhaul period. Equipment includes primary flying instruments and full dual control, though brake controls are fitted only in the normal pilot's position. Although it had flown for the first time only the week before the display Mr. Harrison demonstrated the Autocar fully.

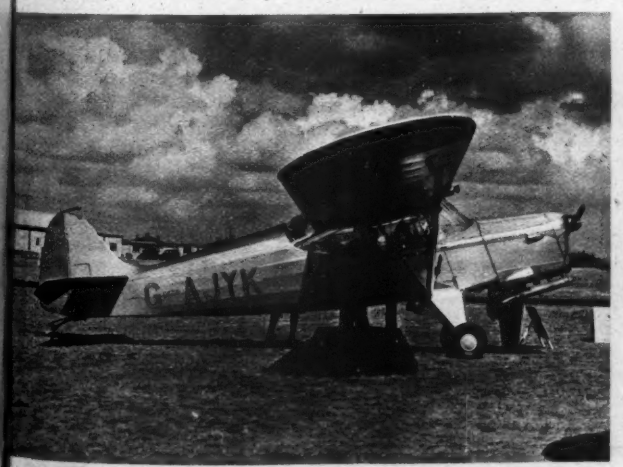
AUSTER AUTOCRAT.—A standard three-seater was available for inspection and its aerobatic ability was ably demonstrated by Mr. R. Porteous, as was the Goodyear undercarriage which, incidentally, is not a standard fitting.

AUSTER AMBULANCE.—Although designed for the special duty of carrying stretcher patients, this type is easily convertible for seating four adults and two children. The starboard side of the fuselage may be taken out to permit a standard military stretcher to be laid behind the front bench-type seat. Special silencing has been provided and the tailwheel is sprung by an oleo leg instead of by the usual leaf spring.

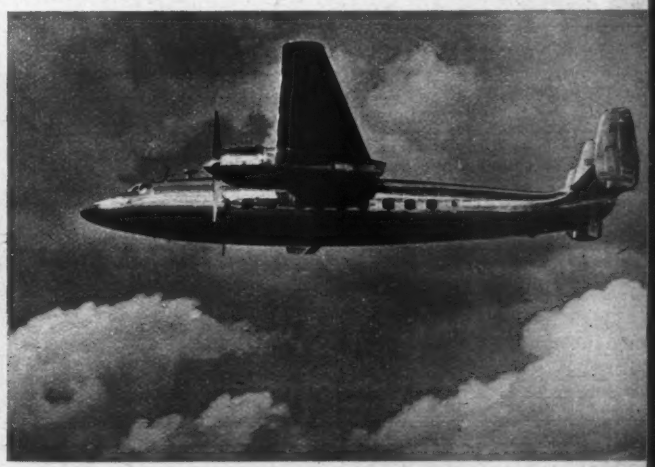
AVRO TUDOR.—An elegant model of the Tudor IX, with four Nenes and a nosewheel undercarriage was to be seen on the A. V. Roe stand in the Static Show: six of these aircraft have been ordered by the M.o.S. as part of its research programme. Some of the ten freighters ordered by M.o.S. for the Corporations are now ready for delivery; they have strengthened floors and protected walls.

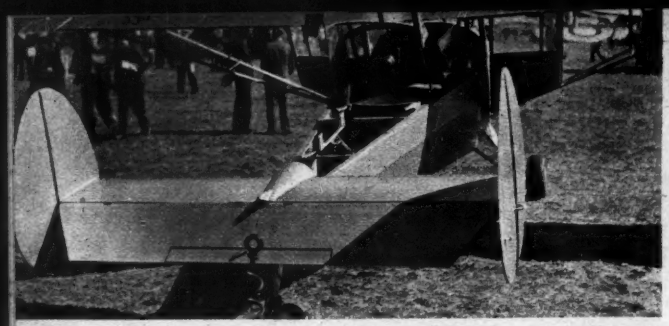
BLACKBURN AND GENERAL AIRCRAFT UNIVERSAL.—Delayed by the move from Hanworth, this huge (162ft span) freighter is nearing completion at Brough; at Farnborough it was represented by a model. The fuselage, tail unit and wings are finished and the power plants are now being fitted in readiness for its first flight early in the New Year. Two prototypes have been ordered by the M.o.S., by whom it has been declared secret again, pre-

The Autocar with a Fairey airscrew takes off in less than 200 yd.

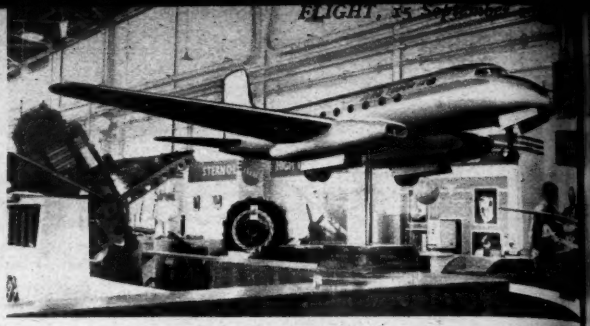


An excellent view can be obtained from the Ambassador.





From an air ambulance—as shown—the Chrislea Series 4 Super Ace may be converted to a four-seater taxi in about 15 minutes.



This model of the Avro Tudor IX illustrates the neat installation of the four Rolls-Royce Nenes. Six are under construction for M.O.S.

THE FARNBOROUGH STORY . . .

Civil . . .

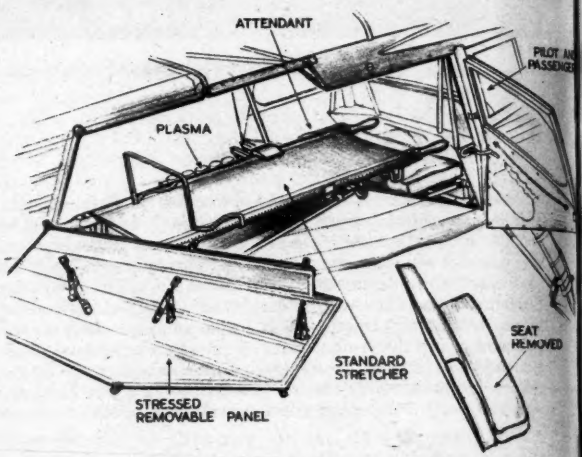
sumably because of its potential value as a troop carrier.

This aircraft is likely to be too large and expensive for our own charter operators, but there have been a number of enquiries from Australia and South America.

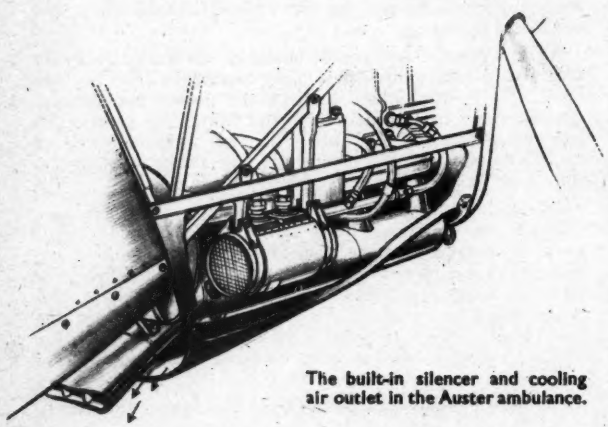
BRISTOL BRABAZON.—Although the first flight took place so happily near the opening of the display, it was not until Thursday afternoon that "Bill" Pegg was able to present this majestic airliner to an eager audience. Unfavourable weather in the West and minor technical snags had caused delay in the initial flight trials.

The splendid sight of the huge Brabazon, in steady, graceful passage some 350ft above the runway, however, helped to make amends for the delay in its début.

BRISTOL 170 WAYFARER.—"Statically" exhibited, this 48-seater "aircoach" version was a Bristol suggestion to



The Auster Ambulance: a four-door four seater with two extra seats for children or alternatively an ambulance for one stretcher. In this sketch the stressed side panel is shown removed.



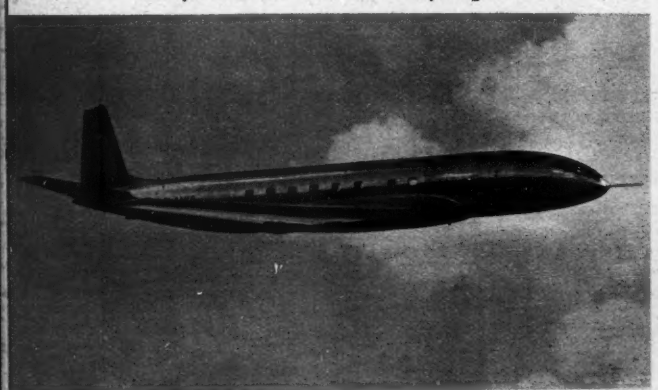
The built-in silencer and cooling air outlet in the Auster ambulance.

charter operators seeking a short-haul passenger transport for high-density routes. Only 30 minutes' work is required to remove the Rumbold seats, fold back the luggage racks and place protective sheets over the soundproof fuselage sides, thereby converting the 170 into a standard Freighter.

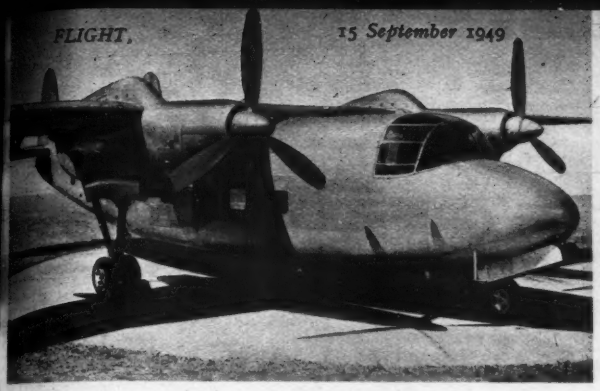
BRISTOL 175.—B.O.A.C.'s experience is being drawn upon to ensure high standards of passenger comfort in this aircraft, which has been designed for the Empire routes. A model showing the interior layout was on view. A payload of 17,610 lb will be carried over 2,300 nautical miles at cruising speeds of 295 kt with Proteus turboprops and 258 kt with Centaurus 663 piston engines. Dimensions of the 175 are as follows: Span, 140ft; length, 114ft; height, 36ft 8.3in.

CHRISLEA SUPER ACE.—Two versions of an attractive four-seater appeared in the static park under this one title.

Glimpse of future air travel: an imposing view of the Comet.



The Dove flies low over the runway.



The Marathon II is the first turboprop-powered feederliner.

The extended nose of the Percival Prince survey aircraft.

The noise level of the Hermes V was low as it flew overhead.

Acquaintance has already been made with the Series 2 Super Ace, of which a production model was shown, but several details of the new Cirrus-engined Series 4 merit especial attention. It is intended not only for private ownership, but for utility duties in all parts of the world.

The rear decking hinges upward, and other modifications to the original Series 2 specification include the incorporation of stick-and-pedal type controls (in place of the dashboard control wheel) and a tailwheel undercarriage. The fitting of Murphy 5-channel V.H.F. radio, with roof speaker, is also an innovation. Newly completed, the Series 4 is due to begin flight trials immediately.

DE HAVILLAND COMET.—When G-ALVG became airborne on its first public demonstration, the chorus of its four Ghost turbojets, so shrill on the ground, was replaced by a low rumble. It made a long, shallow climb to gain speed and, as it banked in the distance against a background of grey sky, it revealed a silhouette as modern as that of any raked-wing research fighter. John Cunningham's purpose, however, was to display his aircraft as a docile, practical transport to carry 36 passengers with unprecedented speed and comfort.

A fast, hushed run across the airfield was followed by a wide, low-level turn at slow speed, which revealed in full a degree of grace never before achieved in the design of so large an aircraft. Although it flew for the first time only on July 27th, development flying has progressed rapidly and a Mach Number of 0.8 has already been reached at altitude.

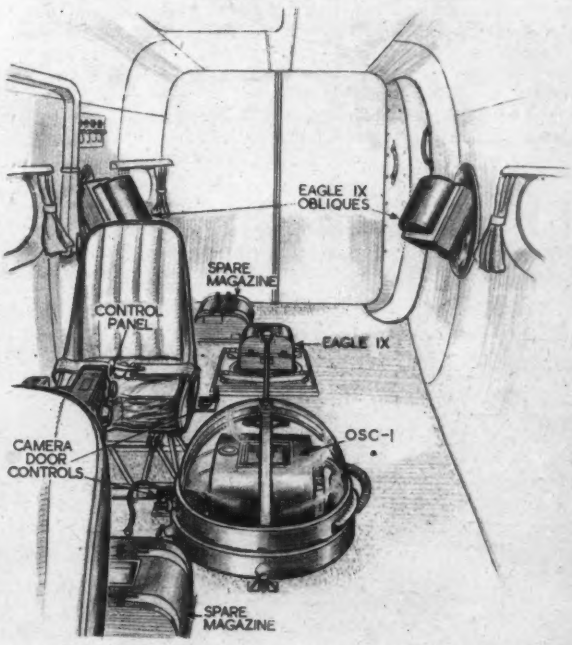
DE HAVILLAND DOVE.—Although it was the first post-war British type designed for airline work and is employed in 33 countries, the Dove is still in line with the most modern piston-engined designs. This year a normal eight-seater was shown and, after flying in one of the "circuses," Mr. Fosset demonstrated a short landing with a reversible-pitch airscrew.

HANDLEY PAGE HERMES IV.—An early performer in the flying programme was the 40-seater Hermes IV, which is shortly due to make an appearance on B.O.A.C.'s long Empire routes. In less luxurious form, incidentally, it can carry as many as 74 passengers. The fact that the aircraft was demonstrated individually at last year's display meant that this year, in common with other types similarly situated, its showing was restricted to a brief fly-past; nevertheless, with Mr. Bloomfield as pilot, its contribution was effective.

HANDLEY PAGE HERMES V.—Like its piston-engined predecessor, the Mk IV, the Hermes V appeared in dazzling metal finish, adorned only by small registration letters and the familiar blue "H.P." hallmark. A few days before the display, ten hours' flying having been completed successfully, 40 Rumbold seats were installed and the cabin soundproofed.

Operating at its new all-up weight of 86,000 lb (an increase of 2,000 lb) the Hermes V has a performance that will interest operators. With 40 passengers and 3½ tons of baggage, mail or freight, it will fly 2,000 miles at 330 m.p.h. and at 30,000ft. Much of the constructors' tooling for the Mk IV, already in production, will be utilized as soon as quantity manufacture of the Hermes V is required. S/L. Hazelden's demonstration of the world's largest and fastest turboprop transport lent weight to the statement

Inside the fuselage of the aerial-survey Percival Prince, showing the two cameras for vertical and two for oblique photography.



In full operational trim, the B.W.I.A. Short Sealand prepares to land.

The Short Solent making one of its low flights along the runway.

THE FARNBOROUGH STORY . . .

Civil . . .

that its performance is well in advance of design forecasts, and illustrated the smooth and quiet operation of the four Theseus turboprops.

HANDLEY PAGE (READING) MARATHON I.—Not included this year in the flying display, this aircraft (which will be employed by B.E.A. on internal routes) was displayed furnished in the Corporation colours and with seating for 20 passengers.

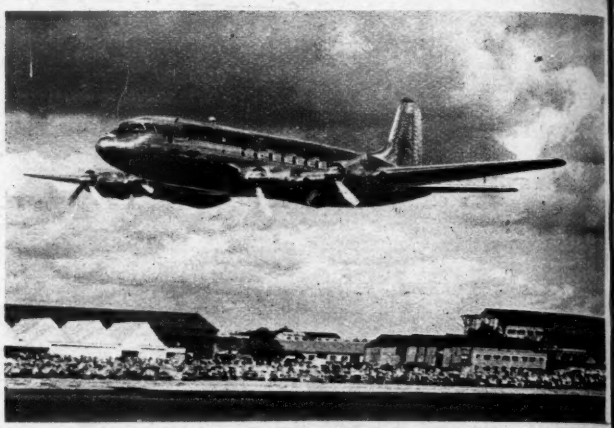
HANDLEY PAGE (READING) MARATHON II.—Turboprop aircraft do, of course, offer passengers a degree of cabin quietness and smoothness quite unobtainable with piston engines, but, aurally, a ground audience is often treated less kindly. On this score, however, there could be no objection to the subdued note of the Marathon II's 1,000 h.p. Mambas as they lifted this experimental, so far unfurnished, feederliner off the runway—or during the brief take-off run (700 yd fully laden) which preceded its startlingly rapid climb.

Overhead, Hugh Kendall feathered one airscrew and gave convincing evidence of the Marathon's excellent handling qualities and half-power performance, both on the climb and in near-silent, flaps-down flight at low throttle.

PERCIVAL PRINCE.—Only uncompleted paper work prevented the official announcement last week that the Prince has secured a Certificate of Airworthiness. All flying has been completed and the certificate should be issued shortly. Two passenger versions were shown at Farnborough, one with ten, and the other with eight seats and more elaborate toilet arrangements. The performance on one engine was demonstrated convincingly by Mr. Powell. Overhaul period for the Alvis Leonides has recently been extended to 400 hours.

The lengthened nose on the survey model not only enhances the appearance but also suggests that the basic design is capable of much further development.

SAUNDERS-ROE PRINCESS.—Staff from B.S.A.A. now employed in B.O.A.C. are co-operating with Saunders-Roe in general layout and interior design for the Princess flying boats, which will operate to South America and perhaps along other B.O.A.C. routes. The model in the static exhibition showed for the first time the wing-tip floats. Since the hull was moved from its building stocks at the end of July, erection has proceeded according to plan. The complete boat will probably be launched towards the end of next year.



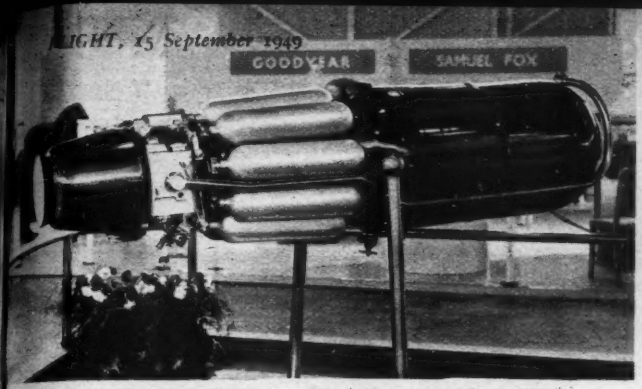
The Hermes IV will soon be flying B.O.A.C. colours.

SHORT SEALAND.—With the markings VP-TBA and the name *R.M.A. St. Vincent*, the first Short Sealand for British West India Airways was demonstrated by Mr. Brook-Smith. A tour of Scandinavia is contemplated before delivery to Trinidad.

SHORT SOLENT.—*R.M.A. Solway*, one of the B.O.A.C. Solent flying boats normally engaged on the South African route, was flown very low and slowly over the runway by Capt. Upton. Solents are in regular use also by Tasman Empire Airways.

VICKERS VISCOUNT.—There is, perhaps, little that the Viscount can do at an air display to enhance its reputation as a very fine transport aircraft, if only for the reason that its greatest attributes—internal silence and freedom from vibration—can be properly appreciated only by those fortunate enough to travel in it. Mr. Bryce flew in circus formation with both port airscrews feathered and from the ground the two working Darts were scarcely audible.

The Vickers Viscount about to touch down.



The Sprite liquid-fuel rocket motor, first of its type to be exhibited.

Part-sectioned Ghost turbojet which gives 5,000 lb thrust.

THE FARNBOROUGH STORY . . .

Power Units

IT is a very good sign that at the mention of engines the mind automatically turns to considerations of specific aircraft installations and the spectacular performances made possible by the advanced power units now produced in this country and shown at Farnborough. There was scarcely a power unit in the static exhibition, in full-scale or model form, that was not also flying in the display. The position was thus very different from that of three or four years ago, when many of our new turboprops and turbojets (and some small piston-engines, too) were but show-pieces, at best flying in test-bed aircraft or with a few hours of ground running to their credit. The British industry does not favour the premature display of mock-ups and units that have never run.

Essential engine data in convenient condensed form was provided in *Flight* last week. Here it is the intention to acquaint readers unable to visit the S.B.A.C. Exhibition with an idea of the merits of the engines displayed, and to mention any new items of information acquired at Farnborough.

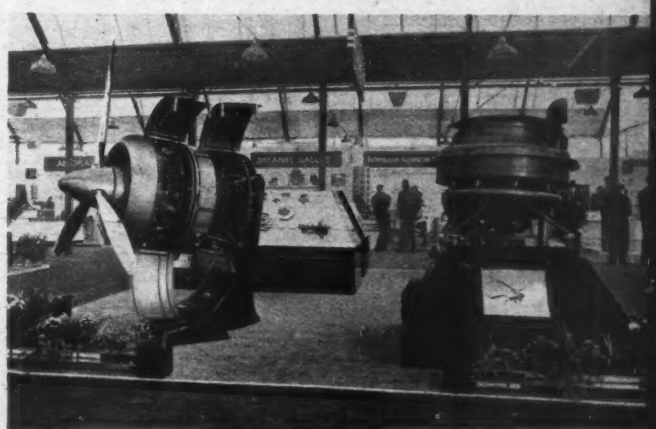
ALVIS, who had a keen interest in several aircraft included in the flying programme and in others—experimental and projected variants—not present, have reasonable hopes that the Leonides will go into service in such aircraft as the Prince with a 400-hour initial overhaul period. All new engines must build up their inter-overhaul periods by experience, and this is being gained in service by units in the Westland-Sikorsky helicopters. On their stand, Alvis showed a bare Leonides engine, a complete power-egg and a helicopter power unit.

ARMSTRONG SIDDELEY had a considerable variety of power units on show, and it seems that the Cheetah radials still have a long life in front of them. The only flying engine-test-bed at Farnborough, the Lancaster with two Pythons (most powerful airscrew-driving engine produced to-day) is theirs, though any doubts regarding the functioning of the Pythons were in any case dispelled by the Python-powered Wyvern. Mambas were to be seen in four-engined and two-engined prototype passenger aircraft, and it is learned that a Dakota with two Mambas has been flying at Bitteswell for a week or more. The Double Mamba will shortly be flying, and there has been some talk of the possibility of lowering the airscrew shaft (relative to the individual compressor shafts) to suit one specific installation. The three gas turbines were exhibited and a complete Mamba installation for the Apollo appeared on the Armstrong Whitworth stand. A Mamba 3 is under development.

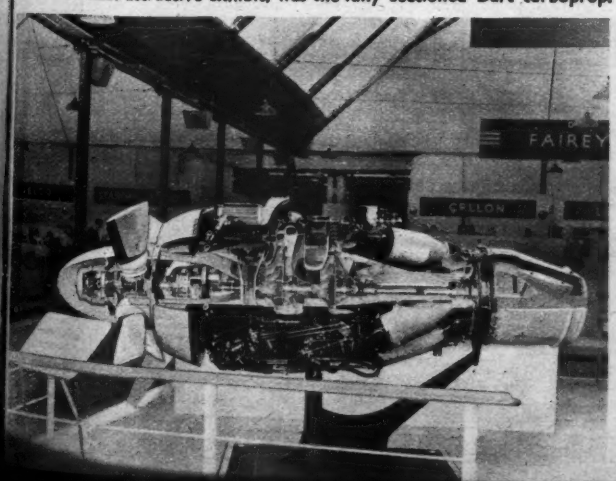
Two other turbojet units to which the company made reference (though they could not show them) at Farnborough are the Adder and the Sapphire. Performance figures for the Adder are given on page 342. Producing 1,100 lb thrust, this is the pure-jet version of the Mamba 2 and is believed to be related to another unit, the Viper, of which only the name has been released. The Sapphire, originally designed and constructed by Metropolitan-Vickers Ltd., is by agreement being developed by Armstrong Siddeley.

BLACKBURN CIRRUS, like other companies producing

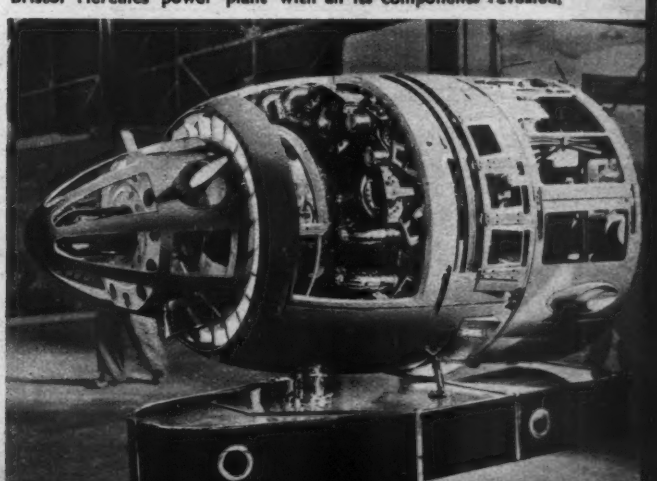
Two variants—one horizontal and one vertical—of the Leonides

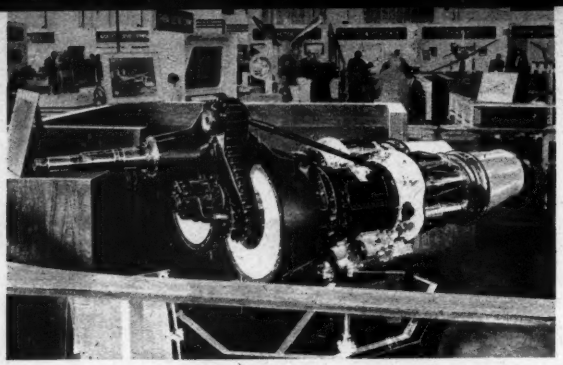


A most attractive exhibit, was the fully sectioned Dart turboprop.

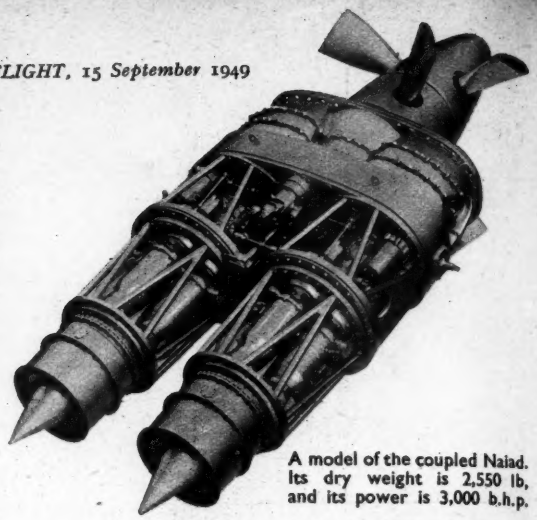


Bristol Hercules power plant with all its components revealed.





Contraprop shafts are prominent on this Double Mamba.



A model of the coupled Naiad. Its dry weight is 2,550 lb, and its power is 3,000 b.h.p.

THE FARNBOROUGH STORY . . .

small civil units, are interested in the economics of operation and particularly in overhaul periods. There seems little doubt that the Minor II will be up to 1,000 hr and the Major III to 800 hr before long. Good progress with Bombardier and Grenadier is reported, but the future of the Grenadier is believed to be in some doubt, due to the lack of new aircraft designs to which it is applicable. Minor, Major and Grenadier, coloured effectively plain black and white, were on view.

BRISTOL exhibits offered a sharp contrast, for in addition to the working, sectioned Hercules power plant for the Hermes IV, a Centaurus and a most attractively prepared Proteus turboprop, there was an old Jupiter. The power installations of the two H.P. Hermes—4 and 5—in the viewing park made an interesting comparison. Most people agreed that the remarkably clean Hercules installation with its big spinner, fan cooling and gently curving petal nacelle is more attractive than the blunter Theseus of similar diameter but with small airscrew spinner and remarkably small air intake annulus.

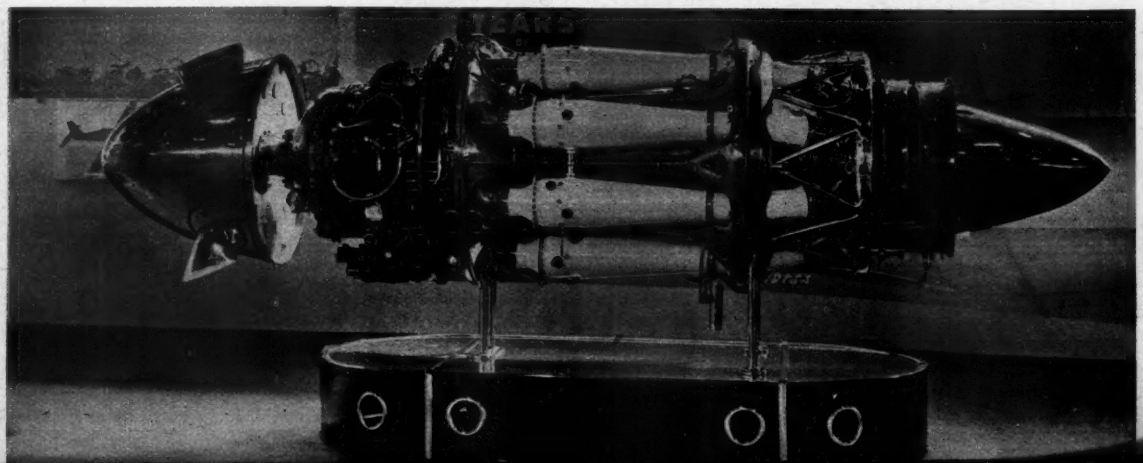
DE HAVILLAND had an engine in almost every class, and whether it was the trainer circus, large airliners or an individual jet fighter demonstration which was in progress, the characteristic squeal of Goblin and Ghost or the healthy buzz of a Gipsy Major or Queen was certain to be heard. A Goblin with after-burning was demonstrated, but at this early stage in its development life only a relatively low thrust increase is obtained. The jet outlet is at present of fixed area.

The four Ghosts in the Comet have the important distinction, by virtue of their type, design (single-sided centrifugal compressor), and equipment, of being ready for operation in any climatic condition likely to be met with by the aircraft. In particular, icing—the great problem with gas turbines in civil aircraft—is not likely to present any trouble. The Sprite rocket motor, described last week, was exhibited for the first time. In addition to a part-sectioned Ghost and a Queen 70 power plant for the Dove, a Goblin turbine wheel, which has completed 1,250 hours' running, was a significant exhibit. D.H. piston engines were to be seen on other stands, such as that of Wellworthy and of John Curran, Ltd. (who specialize in engine mounts and test-bed equipment).

NAPIER have made progress with the Naiad, Coupled Naiad and later units, but none was flying at Farnborough this year. In addition to a complete Naiad installation, a model of the coupled unit was exhibited. In this, as in other such designs, the two Naiads can run independently, and they drive co-axial contraprops mounted on a centrally disposed shaft. With height only 30in the unit would appear to be well suited to wing accommodation. Performance data are given on page 342.

ROLLS-ROYCE had produced one of the finest sectioned engines to be seen at an S.B.A.C. exhibition, namely, a Dart fully cut away and coloured to reveal—for the first time—the interior. Although it was accompanied statically by a Nene and a civil Merlin, the true story of Rolls-Royce progress was to be learned outside. Avons were to be seen in the English Electric A.1 bomber, and a special Meteor, and re-heat Derwents in another Meteor. The Dart installation in an Athena was also uncowled in the park for examination. Nenes powered the most spectacular fighters such as the Supermarine 510 and Hawker 1052, while contraprop Griffons made themselves seen and heard in the Seagull, Shackleton and Firefly. The Avons in the A.1 bomber had close-mesh wire screens in the intakes. This form of ground protection, if retained, would no doubt need to be retractable in flight, for it would seem to invite icing troubles. No new information was forthcoming regarding the Tay turbojet, but it is learned that the Clyde turboprop will not be going into production. Neither of these designs was represented at Farnborough but some performance details of the Clyde, first turboprop to obtain a full civil and military type certificate, are given on page 342. The Rolls-Royce re-heat equipment on a Meteor's two Derwents was most spectacular, and the jet outlets could be varied in area according to requirements, full normal thrust thus being retained when the afterburner was not in use.

A handsome example of the Bristol Proteus free-turbine turboprop, power unit for our largest civil transports.



"STATIC" HIGHLIGHTS

A Tour of Farnborough's Indoor Exhibits

IT is perhaps inevitable that the static exhibition cannot, by the very nature of things, show on the surface the glamour and interest of novelty associated with the display of new aircraft in action. However, the vigorous interest and careful attention paid by the milling crowds to the mulititude of items exhibited on the stands is a clear indication of the enormous value of this side of the Farnborough show.

This year, the quality of display reached an even higher standard and, in contrast to last year, the show was much more conveniently arranged in that the 185 stands were gathered in one (hangar) hall and an extension marquee. In giving this review of the static show, it is quite impossible to give a detailed notice of each stand—a complete directory to the industry was included in our last week's special issue—and we intend, therefore to follow the line we have pursued in the past, namely, to make a verbal tour of the stands and pick out the various highlights which engaged our particular attention. For this reasons, too, the review will follow no particular order or grouping.

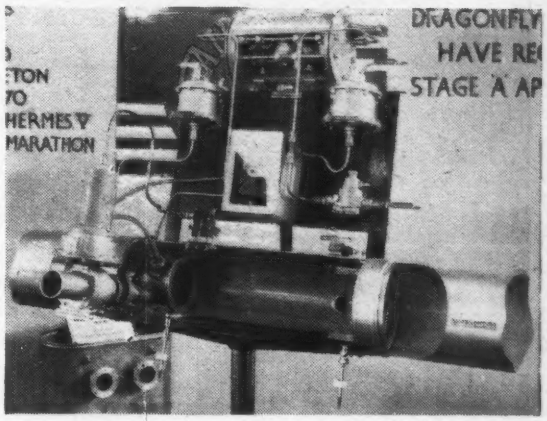
Harley Aircraft Landing Lamps, in addition to the electrically-retractable landing lamp as installed on the Brabazon I and Ambassador, also displayed a novel reading light they have developed for passenger aircraft. By the use of matt-black divisions, diffusion and glare are avoided and the light will give illumination equivalent to a 60-watt lamp over a controlled area serving three side-by-side seats so that use of the light by one person does not inconvenience their fellow passengers.

Skyhi, Ltd., displayed a variety of their aircraft jacking equipment, the largest unit of which is the 15-ton hydraulic quad-jack which is capable of lifting 15 tons through 42in—this in contrast to the little wheel-change jack designed for use with the D.H. Dove and which, with a closed height of but 9⅛in, can lift two tons through 7¾in.

Sensible Trim Control

An extremely neat six-way switch for control-surface trimming was exhibited by Western Manufacturing Estate, Ltd. Designed for use with Miles electric actuators, the switch gives in one small unit correct sense-operation of all trimming motions, i.e., rocking fore/aft for elevators, rocking right/left for ailerons and turning clock/anti-clock for rudder.

Siebe Gorman, Ltd., had on view their latest development of an automatic oxygen-regulator. Fabricated in light alloy, this unit incorporates an aneroid control and is designed to govern automatically the supply of oxygen to no fewer than 50 persons. It is very compact, being only about 8in long and 2½in in diameter, whilst the weight is but 25 oz.



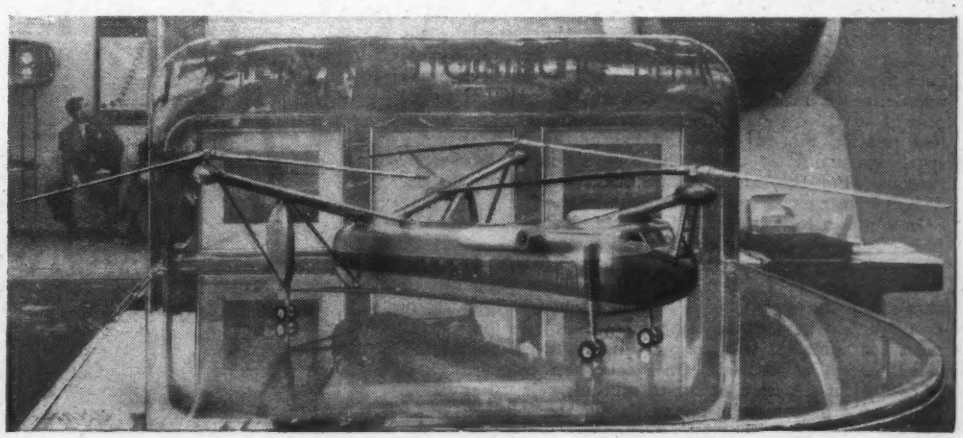
A sectioned Dragonfly combustion heater assembly for employment either in cabin heating or thermal de-icing use was shown on the D. A. Daniel Stand.

Shown by Air Trainers, Ltd., the most modern British version of the Link Trainer was an impressive item. A great advance on earlier models, the new apparatus incorporates complete aircraft and engine controls, an extensive range of flight instruments, including simulation of the gyro compass, and fully automatic operation of radio aids. The interest shown in this exhibit was considerable.

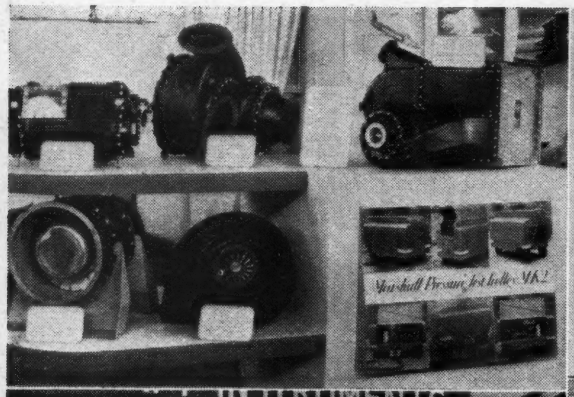
Oldham and Son, Ltd., displayed their new 12-volt, 60-amp battery in which the employment of a light alloy case in place of the conventional ebonite effects the useful weight-saving of 2 lb. This is made possible by the use of unit construction in the form of six separate plate-packs in acid-proof cases, each of which is easily replaceable so that the effective life of the unit is considerably enhanced.

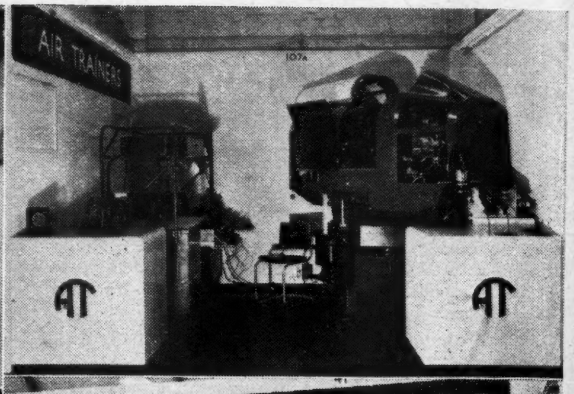
British Messier, Ltd., have developed a variation of their well-known swashplate hydraulic pump in the form of a hydraulic motor. Maximum pressure is quoted as 3,200 lb/sq in and maximum r.p.m. as 4,200, whilst the power output is stated to be 10 h.p. at 2,100 r.p.m.

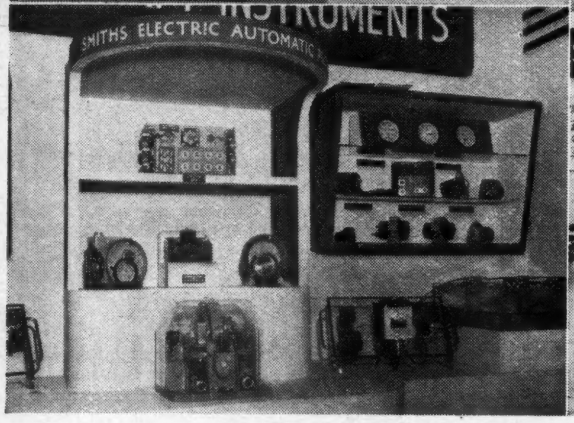
One of the more interesting Normalair exhibits was a pump and accessory unit for use in conjunction with the same manufacturer's humidifier. In a single compact con-



The Cierva Autogiro Co. Ltd. exhibited this model of the W.11T twin-engined version of the famous triple-rotor Air Horse. With increased interior capacity the aircraft may be powered either by Merlin engines or comparable-power turboprops.







(Top left) A representative range of Marshall cabin atmosphere control equipment was shown by Sir George Godfrey and Partners Ltd. (Top right) A full inspection of the latest form of British-built Link Trainer could be made on the Air Trainers stand. (Bottom left) Representative of their wide range of equipment, Smiths Aircraft Instruments exhibited the S.E.P.I., a typical variety of aircraft instruments and a demonstration unit of the Waymouth fuel contents gauge system. (Bottom right) Examples of their highly specialized sheet metal work were shown by the famous Coventry firm of Cornercroft Ltd.

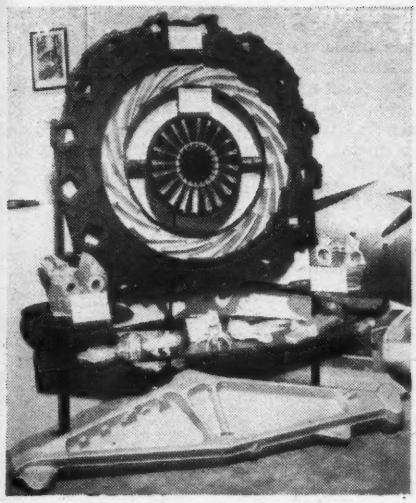
"Static" Highlights . . . . .

tainer are grouped a duplex hydraulic pump driven by an electric motor; delivery and scavenge filters; solenoid valves to control water flow; a thermal safety switch; and a suppressor and relay switch for the motor circuit.

The Ministry of Supply stand carried many interesting exhibits, particularly that of a two-step rocket for supersonic research. In addition, there was a neat demonstration model of the action of after-burning as applied to turbojets. (As noted on other pages, a Meteor and Vampire employing the re-heat system were included in the flying display.) The demonstration model comprised a small blower delivering air down a 3½in-diameter glass pipe in which was arranged a four-prong array of small-bore pipes through which Calor gas was ejected. The gas was delivered on to the apices of four steel cones, the purpose of which was to diffuse the stream and promote turbulent mixing, the gas being ignited in the first place by spark ignition after which, of course, burning was continuous. For the safety of spectators the efflux was deflected by a curved steel baffle plate.

In addition to their well-established ejector seat Martin-Baker Aircraft, Ltd., also displayed their newest automatic model of this most necessary item of safety equipment. With this latest form of seat, the pilot's parachute is stowed in the seat chassis and is opened automatically even though the man may be unconscious. As long as the pilot has sufficient wits to pull down the face blind, his safe ejection is assured. On ejection, a time switch is triggered for a period of six to nine seconds, after which the drogue parachute is released from the seat and automatically pulls out the pilot's 28ft canopy, releasing him at

The latest development of the Martin-Baker ejector seat provides automatic opening of the pilot's parachute.



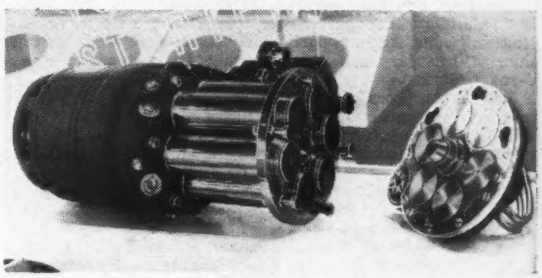
This selection of beautifully produced cast and forged light alloy components was to be seen on the High Duty Alloys stand.

On the Jessop stand could be seen turbine wheels and rotor blades of many famous British gas turbine power units. These exhibits engaged the interest of many foreign visitors.

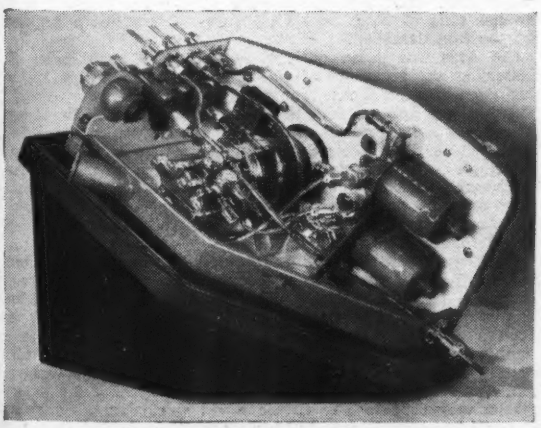
the same time from the seat harness. The time switch is barostatically controlled so that, although the ejection may take place at any height, the time switch will not operate until the seated pilot has fallen to 10,000ft (at about 150 m.p.h.), at which point the separation takes place. Thus, although the automatic supply of oxygen to the pilot is a feature of the design, an unconscious pilot does not leave the seat until below oxygen requirement level.

Nylon webbing is used for the new ZA safety harness shown on the G.Q. Parachute Company's stand. This harness has been developed for the R.A.E. especially for use in high-speed aircraft with ejector seats. In this connection, the company has also developed a combined flying suit, Mae West and harness for use with the new Martin-Baker automatic ejector seat.

Other safety devices were featured on the Schermuly stand. The company has just developed a parachute flare for light aircraft in which the flare units are readily inserted in a light, easily installed ejection tube fitted in the aircraft. By operation of a safety switch, the flare is ejected horizontally 150ft, at which point the parachute opens; replacement flare units can be inserted ready for firing in a matter of 20 seconds and (an important point) the spent case is cool to handle. Each flare has a candle power of 150,000 and a burning duration of 1½ minutes. A new distress signal for aircraft rescue dinghies is a great improvement on the well-known "two star-red" signal. Sealed in a metal case the size of a large cigar, each flare burns with 50,000 c.p. brilliance and also ejects two 45,000 c.p. stars to a height of 200ft. The flare is electrically fired by a special Kalium long-life battery contained in a holder into which the flare case is screwed. Ten flares and the holder are packed into a case measuring only 2in by 7¾in by 5½in, the total weight of which is but 3 lb 14 oz.



Developed for use with gas turbines, this Plessey starter unit will carry six slow-burning cartridges.



This highly finished humidifier pump and accessory unit was one of the items displayed by Normalair Ltd.

Thomas Boorn and Co., Ltd., displayed on behalf of Aero Controls, Ltd., the new plastic roller bearings which have been developed by the Ministry of Supply. These bearings are capable of operating at abnormally low temperatures and in fluids and, designed to meet a requirement for a low-friction, anti-corrosive, non-magnetic, light-weight bearing, are claimed to be easier to maintain than are steel bearings; less likely to seize due to ingress of dirt or foreign matter; and resistant to fungoid growth and tropical insects. An 8in o/d plastic bearing weighs but 17 oz by comparison with a weight of 5 lb for a conventional steel bearing of similar size.

The English Electric Co., Ltd., displayed a variety of rotary actuators of capacities from 30 lb. in. torque through 90 deg in one second up to 60 lb. in. at 2 r.p.m., in addition to a range of linear actuators giving 200 lb up to 16,000 lb thrust with strokes of from one to 13in and operating times of five to 60 seconds.

An example of "cocoon" plastic spray-packaging was displayed on the R.A. Brand stand, the versatility of this method ranging from the complete protection of "anything from a micrometer to a multi-engined aircraft." The simplicity and efficiency of this form of packaging, whereby complete protection is given for periods of from two to ten

Static Highlights . . . . .

years, has already been proved by, among others, the Royal Navy, Rolls-Royce, Ltd., and the Bristol Aeroplane Co., and the demonstrations given at Farnborough will undoubtedly bring forth many new applications.

High Duty Alloys, Ltd., exhibited a representative selection of their cast and forged work in Hiduminium and Magnuminium, among which the Ghost combustion-chamber mounting-ring and an array of turbojet stator blades were centres of attraction.

The Irving Air Chute of Great Britain, Ltd., exhibited their new S type parachute employing a simplified harness with only two adjusters (on the shoulders) and a six-point instantaneous release box. Utilizing nylon lines and canopy stowed in a back-position pack, this new parachute has a design weight of only 12 lb, i.e., some 10 lb less than the present pilot type.

The effectiveness of their synchronization equipment was admirably demonstrated by Rotol, Ltd., by means of a working dioramic model in which stroboscopic illustration of airscrew synchronization was emphasized audibly.

A new lap-type quick-release safety belt, in both civilian and Service types, was shown by Aerolex, Ltd., the chief feature being the positive locking and quick-release design. For locking, the metal tongue is simply pushed home into the slotted buckle and, to release, the finger knob mounted on the buckle merely needs turning through a few degrees. The fastening can be released at a load of 300 lb, whilst the standard webbing belt has a strength of 1,600 lb.

Desoutter Brothers, Ltd., exhibited a wide variety of their famous power tools, the latest of which is a high-speed miniature screwdriver for light assembly work. Incorporating an impact clutch whereby the screw head is protected from damage, this very useful little tool weighs only 8 oz, is but $\frac{7}{8}$in in diameter, and is designed for metal screw/nut assemblies from 3 B.A. to 10 B.A. in size.

BRITISH COMMONWEALTH LECTURE

Avro Jetliner Designer on Gas-turbine Transports

MR. E. H. Atkin, B.Sc., F.R.Ae.S., chief designer of A. V. Roe (Canada), Ltd., is to deliver the fifth annual British Commonwealth and Empire Lecture before the Royal Aeronautical Society this evening, September 15th. His subject is "Inter-City Transport Development on the Commonwealth Routes." Mr. Atkin is particularly conversant with this topic, since it was for such purposes that he designed the Avro C-102 Jetliner.

For the purposes of his lecture he will divide air transport into four categories, defined in terms of stage distances, and will discuss the introduction of gas-turbine aircraft into those regions which, for various reasons, he considers favourable to development.

Mr. Atkin considers speed to be the one factor which generally brings the biggest return to the operator. This, he will point out, is because it gives more tonnage or passenger-miles per thousand miles of annual utilization, reduces the number of aircraft necessary and so reduces indirect operating costs. He does not forget, however, that increased speed of operating brings with it its own problems of traffic control and ground handling of passengers.

Part of the lecture will be devoted to aircraft size. One illustration strikingly shows the amount of fuel which it is physically possible to put into an aircraft of given size and emphasizes that by the law of similarity the available tank capacity is proportional to $1\frac{1}{2}\times$ take-off weight. In fact, Mr. Atkin believes, the figure is slightly better than that as the bigger the aircraft the more feasible does the use of odd spaces in a structure become. For twice the size, three times the amount of fuel can be carried to supply twice the number of engines; hence, there is another 50 per cent fuel emergency allowance available. The lecturer will then go on to review the question of fuel allowance for taxying, stand-off or stacking for alternative airfields and for descent before going to alternatives. Discussing flexibility of operation, Mr. Atkin will comment on the view that, by using the right number of engines for the altitude, a jet can stack at any altitude without a penalty of fuel economy.

Before concluding, he will discuss at some length direct operating costs and the return on the investment in aircraft and, finally, the effect of engine size and fuel economy of direct operating costs of a given aircraft. He believes that there will be a period of operational experimentation preparatory to the full scheduled operation of large transports and that the Empire air routes are, if not uniquely, at any rate particularly suitable for operations during that development period.

MALTA—and the MORAL

"Briefed to Attack—Malta's Part in African Victory," by Air Marshal Sir Hugh Lloyd, K.B.E., C.B., M.C., D.F.C. Hodder & Stoughton; price 18s net.

HERE, at last, is a book which recaptures something of the spirit of Malta in World War Two. Previous books have told of Malta's fight for survival under a non-stop barrage of Axis bombs, and of the Spitfires and the convoys of merchant vessels whose self-sacrifice enabled the island to win through to victory. But that is only part of the story. The real spirit of Malta was far more aggressive; if it had not been, the island might never have been bombed or starved. Neither would it have become the base from which was directed the first assault on Nazi-occupied Europe, for if Malta had not helped to stop Rommel's advance across North Africa the Allies might never have survived to make that assault. In war, chains of circumstance are closely linked.

Briefed to Attack is a history of the 13-month period during which the island suffered its worst air raids and greatest danger of defeat from starvation. But, as its title implies, it is primarily a record of the brilliant work of Malta's Swordfish, Blenheims, Marylands, Wellingtons and Beauforts, which carried the war into the enemy's camp.

Sir Hugh begins by describing how, before he flew to the island as A.O.C. Mediterranean in May, 1941, he was told: "Your main task at Malta is to sink Axis shipping sailing from Europe to Africa." As a result, on arrival, he made a tour of the island to size up its possibilities as an offensive base. He found that Luqa was his best airfield as it had the only tarmac runway on the island—"but one look at it gave me a fright as, apart from its slope, there was a deep nullah at one end, a nasty, rocky, steep-sided obstacle, and a deep quarry at the other." Worse was to come, for "the 'grand finale' to this day's work was to discover that there were only fifty-nine serviceable aircraft, twenty-nine of them Hurricane fighters."

Nevertheless, Sir Hugh used this tiny force so skilfully that within three months it had destroyed, or probably destroyed, 240,400 tons of Rommel's vital supply ships, with another 205,500 tons damaged.

The Axis was in no position to withstand such losses, so Kesselring was given 900 aircraft and told to eliminate Malta. But even during the height of his onslaught, the island's offensive was not halted. Unfortunately, observes Sir Hugh, little news of its successes reached the headlines at home, for it seemed that "There was glamour in riding in the sky in a fast single-seater aeroplane and shooting down an adversary—it savoured of the Knights of old who would gallop at each other on a couple of cart-horses. But the sinking of a ship was a craven act, something not done in the best society—not with aeroplanes, anyhow."

The chapters of *Briefed to Attack* which describe the relentless destruction of Malta's resources are fascinating and dramatic; but those dealing with the war in the surrounding seas hold the most important lessons for the strategist. They leave no doubt of the supreme power of the submarine and bomber in modern naval warfare, a fact which makes sombre reading for island-dwellers like ourselves whose survival depends on seaborne supply. In fact, the story of Malta proves conclusively that in any future world war Britain's survival will still depend on control of the sea, just as it has for the last nine centuries. Only the weapons needed to achieve that control have changed.

J. W. R. T.

B.O.A.C. IN THE FAR EAST: R.M.A. *Ajax*, one of the Corporation's Argonaut class, taking off from Kai Tek Airport, Hong Kong. As related below, the type has recently been temporarily grounded. "Argonaut" is the B.O.A.C. name for the Canadairs.

I.A.T.A.'s Successful Year : B.O.A.C. Solents Fly to Nyasaland : Dublin Airport Losses

ARGONAUTS GROUNDED

B.O.A.C. withdrew all Argonauts from service at the beginning of the month owing to a defect in the engine coolant pumps which had caused a certain amount of overheating. The Corporation had taken delivery of 14, of which five were at various stations along the route—at Cairo, Rangoon, Hong Kong and Singapore. Rolls-Royce have taken urgent remedial action and efforts are being made to make the necessary adjustments without returning the aircraft to base. The remaining nine will continue with training and development but the entire fleet will eventually undergo the necessary modification.

In the meantime, the Corporation has made arrangements to maintain the service between the United Kingdom and the Far East by diverting Skymasters from their normal services between London and Bahrein and London and Abadan. The Corporation charter three Skymasters from Skyways for these routes, on which they will be temporarily replaced by Solent flying boats. The passengers for the normal Argonaut service will fly by the B.O.A.C. Skymasters eastwards as far as Karachi, where Qantas Empire Airways' Skymasters will complete the service to the Far East. The first Skymaster service left for Tokyo on September 9th.

EFFECT OF RESTRICTIONS

THE restrictive effect of red tape upon the movement of goods and upon all forms of travel is blamed by the International Chamber of Commerce (in recommendations to the United Nations Organization) for many of the present economic difficulties in the world. Drastic simplification of all administrative procedure and formalities is urged. An approach has been made to the secretary general of U.N.O. by the president of the I.C.C. as a result of the congress in Quebec last June when representatives from 28 countries discussed ways and means of improving trade. The resolution says that "cumbersome, costly, obscure and changeable regulations and formalities are often as severe a hindrance as the policies from which they arise," and it is recommended that in each country an independent committee of experts should be set up to revise existing practice. It is also recommended that an international committee should start work on standardized rules to be submitted as models for bilateral or limited multilateral agreements or unilateral action.

Similar views have been expressed many times in the post-war years by Sir William Hildred, Director-General of I.A.T.A. Certainly, if travel and trade restrictions were lessened, the airlines and charter companies throughout the world should be in a position to present more favourable balance-sheets.

AIR FRANCE ESTABLISHMENTS

AN analysis of the staff employed by Air France shows a proportion of one aircrew to nine maintenance staff. The proportion of aircrew to the total employed on the ground in all categories is 1 to 12. There are 317 pilots, 198 radio operators, 25 navigators, 18 pursers, 229 flight engineers, 88 hostesses and 138 stewards. The executive staff numbers 55 and in the administrative branch there are 1,234. The operation staff totals 1,603, radio and communications 1,017, traffic and sales 2,239 and reception 218. With a further 6,260 employed on aircraft maintenance, the company has a staff numbering 13,725.

AIRLINE VISITORS

GUESTS at the S.B.A.C. dinner at the Dorchester Hotel (reported on pp. 334-335) included representatives of airlines and independent operators from all over the world. Amongst them were Mr. W. Hudson Fysh, D.F.C., chairman of Qantas Empire Airways, Ltd.; Mr. G. R. McGregor, O.B.E., D.F.C., president of Trans-Canada Air Lines; Mr. H. Riiser-Larsen, president of Norwegian Air Lines; Mr. J. R. D. Tata, chairman of Air India, Ltd.; Brig.-Gen. H. R. Harris, American Overseas Airlines; Mr. A. W. Coles, chairman of Trans-Australia Airlines; Mr. Ivan Holyman, managing director of Australian Airways; Mr. H. G. Christie, chairman of Bahamas Airways; Mr. D. H. Handover, chairman of S.A.S., Ltd.; Col. J. D. T. Louw, South African Airways; Dr. Ing. B. Velani, general manager of Alitalia; Col. Sabbah el Said, managing director of Iraqi Airways; Mr. Eduard Amstutz, vice-chairman of Swissair; Mr. I. S. P. Araouso, director of Cyprus Airways, Ltd.; Mr. O. Johnson, managing director of Iceland Airways; Mr. A. Deetman, K.L.M.; Sir James Frederick, O.B.E., Air-India, Ltd.; Mr. E. J. Dawes, Sudan Airways; Mr. A. C. L. Davis, Sabena; and Capt. J. C. Kelly-Rogers, assistant general manager (technical) Aer Lingus.

AER RIANTA ACCOUNTS

A DEFICIT of £4,589 was incurred at Dublin Airport for the year ended March 31st, 1949, compared with a surplus of £10,788 the year before. In a recent report the chairman explained that the income from landing charges had fallen by one-third, due mainly to the withdrawal of Constellations from service by Aer Lingus, and to the reduction in the number of training flights carried out by that company as a con-

CIVIL AVIATION NEWS . .

sequence. There was also a reduction in the landing fee charged for pleasure flights. Aircraft movements at Dublin were some 3,000 less than in the previous year, but the number of passengers passing through increased from 162,761 in 1947-48 to 175,333 in 1948-49. During the year under review the main developments at the airport included the erection of freight depots and a garage. Runway lighting had been completed and construction of a third large hangar had been started to provide extra accommodation for Aer Lingus. At March 31st, 1949, the staff numbered 202.

I.A.T.A. ANNUAL REPORT

DR. ALBERT PLESMAN, president of K.L.M., was due to take office last Monday, September 12th, as president of I.A.T.A. in succession to Mr. Gilbert Perier, president of Sabena, when some 200 officials of the 70 I.A.T.A. member-airlines and observers from international organizations attended the opening session of the Association's annual general meeting at The Hague. The event marked the 30th year since international air transport began on a regular scheduled basis and since I.A.T.A. was founded at The Hague in 1919.

The report of the director general, Sir William Hildred, showed that members of the air-transport industry had amassed 12,000 million passenger miles, 100 million ton-miles of cargo and 250 million ton-miles of mail during 1948, each of which totals represented a substantial increase over the previous year.

The director general went on to point out that the keynote of I.A.T.A. activity in matters of world transport was internationalism pure and simple and the removal of all unnecessary barriers to the right of the airliner to fly where it would. He urged greater flexibility in the rate recommendations of the I.A.T.A. Traffic Conferences to promote off-season travel; airline support for efforts to reduce and simplify red tape in customs, immigration and other border formalities; greater attention by airlines and governments to problems presented by jet aircraft; an effort to close the gap between increasing air transport and the development of airports landing and navigation aids; multilateral agreement on air transport rights between nations instead of the present limited bilateral agreements; and delegation of greater responsibility for operations to the airlines themselves by governments.

In Sir William's view the airlines must provide travelling facilities for the masses. A great deal had been done in the revision of fares in the face of increasing operational and labour costs. There was, however, a rich potential reservoir of mass foreign travel in both the United Kingdom and the U.S.A. Reductions made in cargo rates to attract bulky shipments had shown immediate and startling results in the volume of cargo carried, and the trans-Atlantic crossing was an example in the reduction of fares. Not so long ago it had cost $1,000 for the round trip between London and New York, whereas next month it would cost only $466.

The airlines still required public support, but eventually aviation would be able to stand on its own legs and it was the director general's plea that each government should regard the problem as a whole, in order to avoid one branch insisting that subsidies should be reduced while another clamoured for higher landing fees and still a third insisted that mail rates should be cut. In considering international regulations, he felt that the airlines of the world should subscribe to the proposition that international regulations should be written in broad general terms and that excessive details should be prevented or eliminated. He hoped that the manner in which the right to fly was chopped up into hundreds of little bilateral treaties would come to be regarded as a fundamentally wrong approach.

SOLENT ROUTE CHANGE

FROM the end of this month B.O.A.C. will modify the route of one of the three Solent services which fly each week to Johannesburg. The aircraft will fly *via* Lake Nyasa in East Africa instead of by way of Victoria Falls in Central Africa.

RELAXATION: The interior layout and seating arrangements of the B.O.A.C. Argonauts provide a degree of comfort which is particularly appreciated on the Empire routes to the East. Accommodation is normally provided for 40 passengers with an extra six seats in the lounge, but B.O.A.C. has recently been carrying only 25 in order to leave space for exceptionally large loads of baggage and mail.

The Solents will alight at Cape Maclear on the extreme southern end of the lake—so that the northern stage from Port Bell will be 1,027 miles and the southern stage from Johannesburg 1,020 miles. The journey from Southampton to Johannesburg *via* Lake Nyasa will total 6,455 miles, compared with 6,410 miles on the present route.

The change is purely experimental and will be made initially for three months in order to provide an air link with Northern Nyasaland where, it is understood, a vast area of land is being developed by the Colonial Development Corporation. Sir Miles Thomas left London on September 9th for Nairobi to secure the fullest co-operation between B.O.A.C. and local enterprises in Southern Rhodesia and Nyasaland. He will be away until September 27th.

AIR CHARTER

BROKERS report that during recent weeks air chartering has been particularly slack and that no obvious reason has been found to account for it. In those enquiries which have been made, small consignments were prominent and charter aircraft have accepted small loads for completion. The scheduled airlines have been able to offer more favourable rates and conditions for freight, due to the absence of bulky loads. Medium-sized aircraft are quoting high rates for week-end employment, owing to their associate commitments with B.E.A., which leave very few aircraft on the market for Saturdays and Sundays. B.O.A.C. have been particularly busy, carrying valuable skins from South Africa to London—one consignment consisted of 11,000 pelts weighing 2½ tons. The Corporation has recently reduced its rates for karakul skins from 6s 9d to 5s 5d per kg for quantities of 500 kg and over. It is understood that increasing numbers of farmers from South West Africa are now sending their pelts to this country by air, thereby gaining extra time for lambing before the sales.

LUBRICANTS TANKER

A NEW vehicle for replenishing aircraft with lubricating oils and auxiliary fluids has recently been put into service. The equipment, designed by Shell-Mex and B.P., Ltd., and built by Thompson Bros. of Bilston, consists of a tank with four 220-gall main compartments for various grades of oil, and three 60-gall intermediates for de-icing and other special fluids. Each compartment is discharged through its individual meter, flexible delivery hose and trigger nozzle by compressed air at 50 lb/sq in—fed to all compartment airspaces by a compressor driven by the engine of the vehicle.

The tank is shrouded by flat panelling and the roof forms an operating platform in which 14 hatches are cut, giving access to all service points and delivery hoses. The main-compartment hoses are carried on two reels on each side, attached to the tank and buried in the panelling. In operation, the vehicle is driven head-on to the aircraft being serviced, and from the platform the operators have ready access to engines and mainplanes.

BREVITIES

MR. HUDSON FYSH, chairman of Qantas Empire Airlines, arrived in London from Australia on September 2nd. He was met by Sir Miles Thomas, chairman of B.O.A.C., with whom he will have consultations.

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Two Auster Autocrats ordered by the Arab Airways Association are being delivered by air to Amman in Transjordan. The flight of some 4,000 miles is expected to take just over three days.

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The pending retirement of Mr. Ivor H. McClure, assistant secretary-general of Navigation for I.C.A.O., has been announced. Mr. McClure has held this position with I.C.A.O. for the past four years and will be retiring in his 60th year.

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Pan American Airways have claimed a new trans-Atlantic record by carrying 1,626 passengers—792 of them from London alone—from Europe to the U.S.A. in one week. Between August 31st and September 6th 36 flights were made, with an average load of 42 passengers.

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During August, Aer Lingus carried 33,427 passengers on scheduled services, an increase of 23 per cent over the figure for the same month last year. This was accompanied by even larger increases in the freight and mail carried, although there had been only a 5 per cent increase in services operated.

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The Glenn L. Martin Company's losses caused by cancellations of Martin 2-0-2 orders are estimated at 12 to 16 million dollars. Nevertheless, it is predicted by a member of the Reconstruction Finance Corporation, which is responsible for financial loans to the company, that the 2-0-2 "will prove itself the biggest money maker of them all in six months."

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On October 1st Air France will withdraw the direct Glasgow-Paris and Belfast-Paris services for the winter. The company believes that the very early start necessary from these terminals to link up with other services in Paris would be unpopular with passengers during the winter months, and arrangements have been made for Air France night services from London Airport to connect with the day train services from Scotland and Northern Ireland. The company's offices in the two cities are to remain open during the winter for bookings.

A public-address system that automatically announces aircraft arrivals and departures at the push of a button has been installed at Seattle-Tacoma Airport. The automatic system is expected to save about 1,400 dollars in monthly operating costs as compared with those employing live operators.

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B.O.A.C. passenger and freight revenue on the North Atlantic route during the four-month period which ended on July 31st totalled nearly 3,000,000 dollars. This figure is understood to be the largest recorded over any four-month period.

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A new three-bladed Curtiss electric hollow-steel airscrew, designed to improve take-off and climb and also increase speed on large aircraft, has been approved by the C.A.A. for unrestricted use on L.749S and 749A Constellations at gross weights up to 107,000 lb.

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Large quantities of food, medicine and clothing were flown into Ecuador by Pan American-Grace Airways after the recent earthquake. The company placed its full facilities at the disposal of the Government, carrying supplies into Ambato and evacuating the injured.

FROM THE CLUBS

ALTHOUGH weather was ideal for flying in July and August, the number of hours flown at Strathtay Aero Club, Perth, was disappointing; it is thought that the holiday season may have been largely responsible. A Club Day was held last month, in which two races were flown and several competitions took place. A buffet dance made a cheerful conclusion to the day's proceedings.

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SINCE the post war reopening on April 15th, 1946, the Wiltshire School of Flying has trained 263 pilots. Eighty-six members have qualified for and obtained "A" Licences, and another 52 have effected renewals. One member has secured his "B" Licence. During 1948 the School flew 2,556 hours and from January 1st this year to the end of June the total hours have numbered 984. There are 40 non-flying members and 194 flying members, of whom many are private owners of aircraft.

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THE Aero Club of India is organizing an air rally and pageant to take place at Calcutta next January. It will be the first event of its kind to be held in India since the war and Vampires, Tempests, Constellations, Skymasters and Dakotas are expected to take part. Invitations have been sent to flying clubs in India and overseas and trophies and shields will be awarded for aerobatics, formation flying and other contests. It is expected that the Governor-General (Mr. C. Rajagopalachari), the Prime Minister (Pandit Jawaharlal Nehru) and Service chiefs will be present.

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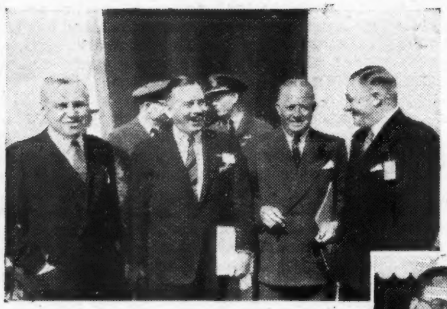
MEMBERS of the Ultra Light Aircraft Association have recently been offered the use of Eaton Bray airfield, near Leighton Buzzard, with its various facilities. Two air displays have been held at the airfield this year, and the Association is hoping that interested members in the Bedford district will appreciate the potentialities of the airfield and form a group in the vicinity.

An inaugural meeting is to be held this month in Birmingham for the Midland Ultra-Light Flying Club, and those interested are invited to contact Mr. J. E. Harding, 755, Warwick Road, Tyseley, Birmingham. The Aerotech Club—which, until recently, was flying from Elstree—has now moved to Blackbushe, where it is hoped that activities will shortly commence.

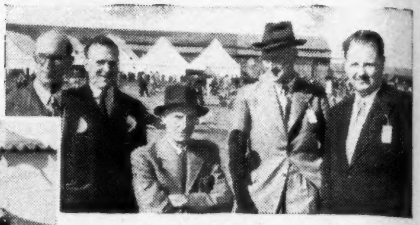
TOURING PARTY: Representatives of the Air Ministry and the M.C.A. who took part in the recent A.B.A.C. tour of flying clubs. Left to right (front row) are Mr. G. H. M. Miles, (under the "Y" in "Airways"), chairman of the A.B.A.C.; Mr. Ewart Bradshaw, chairman, Blackpool and Fylde Aero Club; Mr. de Freitas Under Secretary of State for Air; Mr. F. E. Darlow, A.B.A.C. vice-chairman; W/C. K. J. Powell, Mr. D. E. Proudlove, and W/C. L. G. Schwab.

PERSONALITIES AT FARNBOROUGH

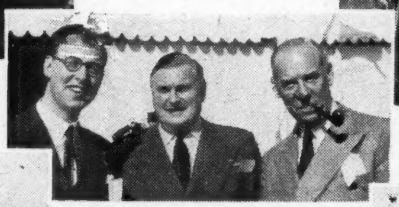
"Flight" Photographs



Mr. C. C. Vinson, Sir Archibald Rowlands, Sir Frank Spencer Spriggs and Sir Roy Dobson.



Mr. A. E. Hagg, Mr. A. F. Burke, Sir Geoffrey de Havilland, Mr. F. T. Hearle and Major F. B. Halford.



Mr. Peter Masefield, Lord Douglas and Mr. K. J. G. Bartlett.

Mr. B. M. Dodds, Mr. A. Dukinfield Jones, Mr. J. Lankester Parker and F/L. H. J. Piper.

Mr. R. V. Perfect and Air Chief Marshal Sir Frederick Bowhill.

A.V-M. R. O. Jones, Sir Richard Fairey and Sir John Buchanan

Major G. H. Abell, Mr. George White Sir George Stanley White and Capt. C. F. Uwins.

Mr. E. C. Bowyer with Field Marshal Sir William Slim.

Mr. R. J. Norton with Mr. H. P. Folland.

Rear Adm. L. D. Mackintosh of Mackintosh, R.N., Adm. Sir John Edelsten, R.N., Vice Adm. Sir George Creasy, R.N., and Air Marshal Sir Victor Goddard.

Lord Pakenham, Lord Brabazon and Sir Harry Brittain.

(Left) Sir Arthur Gouge, Air Cdre. A. F. Hutton and Air Cdre. G. W. Hayes. (Above) Air Cdre. Whitney Straight and Sir Miles Thomas. (Right) Mr. G. Geoffrey Smith, Mr. J. E. Scott, Dr. Llewellyn Smith and Mr. A. G. Elliott

EXHAUST REHEAT for TURBOJETS

PART II: *Development of Later Designs to Improve Performance*

By A. P. JOHNSTONE, A.M.I.Mech.E., A.F.R.Ae.S., National Gas Turbine Establishment

IN an attempt to improve the operational characteristics of the reheat system a new type of stabilizing chamber was introduced. This had been developed for use in turbojet combustion chambers and had shown a good performance. The flame was stabilized by injecting fuel upstream into the wake of a hemispherical baffle. The combined effect of the air flow around the baffle and the entrainment of gases by the fuel spray produced a region of flow reversal in which hot and burning gases were recirculated to the root of the fuel spray, thus making the flame self-piloting. Ignition was effected by a simple spark gap situated behind the baffle.

In the reheat application (Fig. 4) the baffle was housed in a cylindrical body attached to the tail of the exhaust cone bullet and air was fed into it through the annular gap formed between the housing and bullet tail. Having obtained a reasonable stability range from the pilot chamber, various methods of main fuel injection were tried with the object of obtaining the maximum possible thrust boost whilst maintaining a high combustion efficiency. It was found that the limit was reached at 10-15 per cent thrust increase, any further increase in fuel flow resulting in excessive burning beyond the final nozzle.

Attempts to widen the flame front by spreading the reheat fuel over a wider area met with little success, and it was concluded that at these high gas velocities the rate of flame propagation through the mixture was too slow to achieve complete combustion within the given length. It was then realized that to achieve high thrust boosts it would be necessary to adopt some form of multi-stabilizer system and all work on central pilot chambers were therefore abandoned.

The earlier reheat experiments had shown that there were definite limitations to the performance of a reheat system having one central flame-stabilizer, especially in the case of units with short exhaust pipes. Further limitations had been imposed by structural considerations, the reheat duct having to be installed in existing airframes where space was very limited. It was realized that the installation difficulties would have to be ignored for the time being and all effort concentrated on the functional aspect of the system.

In consequence, a reheat duct was designed which would give the ideal conditions for combustion and which could be attached to the outlet of the standard exhaust-cone assembly of a Power Jets W2/700 unit. The diameter of the burning zone was calculated to be 21in, which gave an inlet Mach number of 0.2, and the length was fixed at 7ft. To obtain a high inlet efficiency, the diffusing section between the exhaust-cone outlet and the reheat duct was arranged to have an included angle of 10 deg, making the total length of the reheat duct 11ft. The layout of the duct is shown in Fig. 5.

Choice of a suitable combustion system was the next problem. To be successful, the combustion equipment had to operate at fairly high velocities and have a low installation loss. Further, each stabilizing unit was required to handle a much greater quantity of fuel than hitherto.

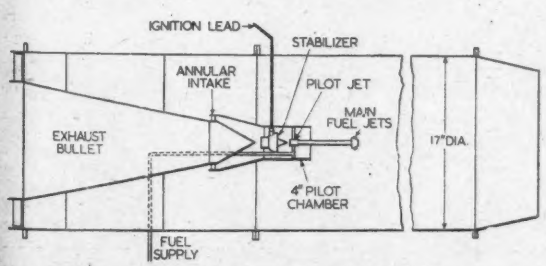


Fig. 4. Arrangement of central cone and baffle chamber system

PART I of this article, published last week, gave an account of the early investigations into the problems of afterburning. Experiments and tests with systems embodying a pilot-flame chamber and a variety of methods of supplying the fuel were described, and the results recorded.

In this issue the story is continued, with particulars of the multi-stabilizer system, which has a wider operational range. Performance figures of this later equipment bring the disclosure of information, within the limits imposed by security, up to date. The article is concluded by an account of the development of variable-area exit nozzles, an essential of any practical reheat system.

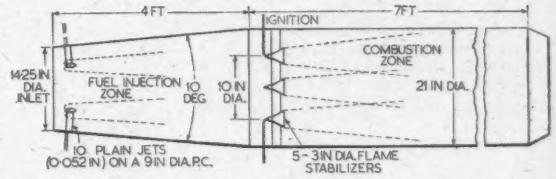


Fig. 5. Multi-stabilizer system for improved combustion.

A survey of existing combustion systems had shown that the only type which might fulfil all these requirements was one in which the fuel and air were mixed prior to entering the combustion zone and where flame stabilization was maintained in the turbulent wake formed behind a simple conical baffle. An essential requirement of this technique was that the fuel should be injected upstream into a region of high gas-velocity to ensure good atomization of the fuel.

The final arrangement, as tested on this type of engine, is shown in Fig. 5. Fuel was injected through ten plain jets mounted on the inlet of the diffusing section and the resulting air-fuel mixture was burnt and stabilized on four 3in dia. conical baffles mounted at the entry to the combustion duct. To initiate combustion, each stabilizer had a small sparking plug mounted in the apex of the cone so that the spark gap protruded through into the inside of the baffle. Once combustion had been established, the high-voltage supply to each plug was cut off and the stabilizers became self-supporting.

The most difficult problem associated with this type of combustion was to obtain the correct fuel distribution in relation to the baffle positions. In the absence of a suitable instrument for determining the actual air-fuel distribution, the method of trial and error had to be resorted to. On first thoughts, it had appeared that the ideal arrangement for a fuel injection system would be to utilize the existing parts of the exhaust-cone assembly. This could be done without offering further restrictions to the gas flow. A fuel manifold was fitted inside the exhaust-cone bullet and eighteen 0.038in dia. holes drilled radially into it. By this means, the reheat fuel could be injected outwards into the gas stream and swept downstream into the combustion duct.

For these tests, a single conical baffle was mounted centrally in the mouth of the combustion duct. It was found that at maximum turbine speed and a reheat fuel flow of 3,800 lb/hr flame flash-back occurred. The flame shot back into the diffuser, causing very bad vibration and melting of the stabilizing system. By moving the stabilizer outwards in steps of 1in and determining the weak blow-out limit in each case, a rough idea of the fuel distribution was gained. Indications were that a rich central zone existed which weakened-off rapidly with increased radius.

In an attempt to overcome this difficulty, several fuel-injection manifolds were constructed, each of different diameter, which could be mounted in the diffuser mouth. Each ring was fitted separately, in conjunction with four 3in dia. stabilizers mounted on the mean radius of the combustion duct. A series of tests were made to establish the stability range of each arrangement and to note any recurrence of flash-back. It was found that flash-back could be avoided by using a 10in dia. manifold having sixteen 0.046in dia. jets and that fairly stable combustion could be obtained.

Due to mechanical defects in the ring injection system, a simplified design was incorporated which consisted of separate streamlined jet holders attached to the inner wall of the diffuser inlet and connected by an external ring main. After several modifications to jet positions and number of jets, the best results were obtained by using ten 0.052in dia. jets equally

Exhaust Reheat for Turbojets . . .

spaced on a 9in dia. pitch circle. The four stabilizers were carried on a 10in dia. pitch circle.

Mechanical failures associated with the sheet-metal parts of the exhaust cone and reheat chamber were attributed to the vibrations set up by the reheat combustion process. Cracking at the trailing edge of the exhaust fairings was the most common of these troubles, but it was finally overcome by increasing the material gauge and adding internal stiffeners to prevent "panting." Splitting of the re-heat chamber walls was eliminated by increasing the material gauge and by specifying electric-arc welding on all butt joints. In all cases, cracking had occurred at points adjacent to gas-welded seams. No trouble was experienced with the fuel injectors or flame stabilizers. It was necessary, however, to renew the spark plugs occasionally.

It has already been stated that the normal turbine operating conditions should remain constant with or without reheat in operation. All results were therefore measured and compared at these conditions, that is, constant turbine-outlet temperature, pressure and Mach number. For convenience, these values were measured at the exhaust cone outlet.

To obtain this basic data, a W2/700 unit was fitted with a standard jet pipe and a full set of readings taken at maximum conditions (16,750 r.p.m. and 640 deg C jet temperature). The mean Mach number was obtained by traversing the jet pipe both in the horizontal and vertical planes.

The mean readings of pressure, temperature and Mach number obtained from these traverses were used in the theoretical performance estimates to determine combustion efficiency. Expressed in terms of temperature rise through the reheat chamber, this is:

$$\eta = \frac{T_{tc} - T_t}{T_{ta} - T_t}$$

where T_t = total temperature at inlet to chamber.

T_{tc} = total temperature at outlet (calculated from theoretical results).

T_{ta} = total temperature at outlet (calculated from test results).

To obtain an accurate theoretical assessment of reheat chamber performance, the pressure loss due to the reheat installation had been known. This could be obtained only by measuring the actual thrust loss on the test bed and converting the results in terms of pressure loss. The thrust loss for the system was found to be 2.3 per cent of normal take-off thrust and this corresponded to a pressure loss in the pipe of 0.45 lb/in².

In the final reheat tests some difficulty was experienced in maintaining constant turbine-outlet conditions whilst adjusting the reheat fuel flow. It was overcome by maintaining constant turbine speed and taking measurements of varying values of reheat fuel flow in the region of maximum turbine conditions. The results for each test were then plotted against turbine outlet pressure and the correct result read off the curve at the point corresponding to maximum outlet pressure. This work was repeated for different final nozzle sizes over the full fuel-flow range. The results of the complete series of tests are presented in Table 2 and graphically in Fig 6.

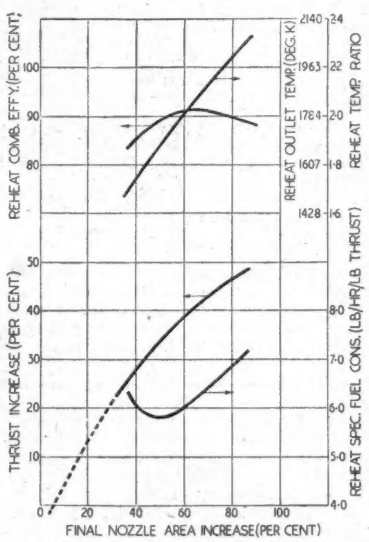


Fig. 6. Test results, multi-stabilizer system on W2/700 unit. Constant reheat chamber inlet conditions.

The tests have shown that by means of a simple reheat system it is possible to obtain, at ground level, a static thrust boost range of 28-48 per cent. At 40 per cent boost, the most efficient operating condition, a combustion efficiency of 91 per cent was obtained and a reheat specific fuel consumption of 6.0 lb/hr/lb thrust increase. The installation loss was 2.3 per cent of the normal take-off thrust.

Experience with this system has shown that jet-pipe cooling should not be an insuperable problem, since repeated tests have been run at gas temperatures of 2,100 K* with no cooling beyond that of natural convection. Further cooling will be needed, however, before an aircraft installation is contemplated. To what extent this can be overcome by maintaining better control of the fuel distribution is not yet known and can be assessed only by further development. Apart from inevitable teething troubles, little mechanical trouble was experienced throughout the final tests.

While development work continued on the full-scale system, it was considered desirable to carry out some controlled experiments with the cone-type stabilizer to determine the range of mixture strengths in which it was capable of stabilizing a flame and to see how this ability varied with altitude. The test apparatus (Fig. 7) consisted of a 4in dia. duct mounted co-axially in the jet pipe of a W2/700 unit. The flame stabilizer was mounted near the downstream end of the cylinder and uniform fuel-air mixtures were passed over it from an appropriate injection system situated near the duct inlet. Airflow through the chamber was controlled by a suitably perforated plate fixed to the intake and straighteners were fitted internally to even out the flow.

The results showed that at ground level, at a Mach number of 0.2, a 2in dia. cone was capable of stabilizing a flame over an air: fuel range of from 14:1 to 60:1. The static pressure in the chamber at these conditions was 20 lb/sq in abs. The complete unit was then installed in the tail of a Wellington aircraft and a series of altitude tests carried out. It was found that above 23,000ft light-up was not possible at any fuel flow.

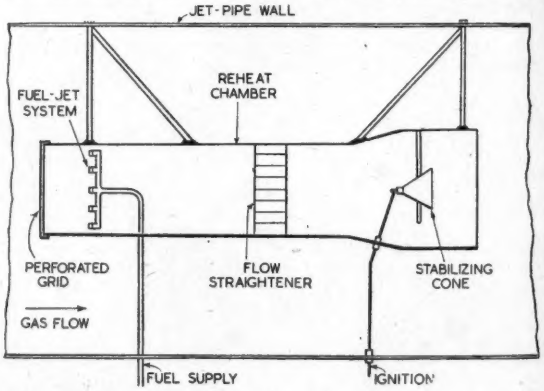


Fig. 7. Small-scale reheat chamber installed in jet pipe.

It was decided, therefore, that the baffle-cone size should be increased to 3in dia. and the tail end of the duct increased accordingly. At ground level the fuel-flow range was then 3:1 and at 28,000ft was still 2.2:1. At that altitude the static pressure in the chamber was 7.5lb/sq in abs, which is equivalent to the conditions existing in a slightly larger

TABLE 2: Performance of W2/700 turbojet with multi-stabilizer reheat system. Turbine outlet conditions (max); Mach No. -0.503, Temperature—916 K, Static pressure 19.98 lb/sq in abs.

	Nozzle dia. (in)	Jet pipe length (in)	Jet pipe dia. (in)	Thrust (lb)	Reheat fuel flow (lb/hr)	Reheat spec. fuel cons. (lb/hr/lb)	Gross spec. fuel cons. (lb/hr/lb)	Thrust inc. (per cent)	Temp ratio	Comb. eff. η_c
Standard unit ...	12.8	48	14.25	1,910	—	—	1.15	—	—	—
Equipped unit ...	13.0	84	21.0	1,866	—	—	—	−2.3	—	—
Reheated unit ...	15.0	84	21.0	2,387	3,280	6.23	2.29	28.3	1.73	83.4
" "	16.0	84	21.0	2,525	3,920	5.90	2.42	35.8	1.93	90.4
" "	17.0	84	21.0	2,700	5,620	6.70	2.90	45.2	2.20	89.8
" "	17.5	84	21.0	2,764	6,970	7.21	3.32	48.6	2.33	88.7

[* *Kelvin scale, which commences at absolute zero temperature, i.e., −273.1 deg C.*]

turbojet at 500 m.p.h. at 45,000ft. These tests served to show that the principle of mixing prior to stabilizing in the wake of a simple cone was sound and that further full-scale development of this system should be continued without delay. It is not yet possible to give the results of this later work, as they are still incomplete, but it can be said that numerous improvements have been made, of which the most important is that of having a far greater control over fuel distribution without adversely affecting the installation losses.

The need for a variable-area nozzle in an exhaust reheat system cannot be over-emphasized, for without it the full benefits of reheat cannot be realized. The design of a variable nozzle for use at high thrust boosts present a difficult problem which, if the solution is allowed to lag too far behind the development of reheat, will seriously delay application to operational aircraft. The theoretical requirements have been dealt with earlier and it remains to discuss the design problems and to record the progress so far made.

Development of Variable Nozzles

An account is given of the earliest experiments on variable nozzles and details are provided of one particular type resulting. Unfortunately, this design came too late to be used in the earlier flight work but is now undergoing further development for use with the latest high-boost systems.

To witness a high-boost system in operation is to appreciate the difficulties confronting the designer. The nozzle is situated at the hottest part of the exhaust duct and is required to operate at red heat. To what degree it can be cooled is not yet known, but it is unlikely that the amount will be appreciable. The most difficult problem to overcome is that of distortion, and for this reason the design should be extremely simple and yet robust, all intricate mechanisms being avoided wherever possible. Operating loads must be reduced to a minimum, as such reduction not only simplifies the controls but helps to solve the distortion problem. The need for simplicity is coupled with that of weight reduction. Weight is an important factor from the aircraft point of view, especially

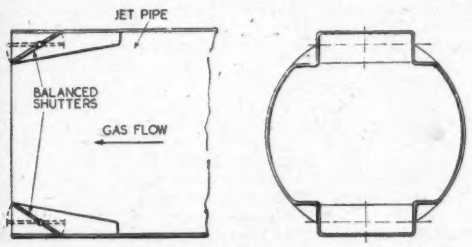


Fig. 8. First variable nozzle, twin-shutter type.

in the case of single-power-unit types, where the additional weight will be concentrated at the tail. All the problems are aggravated by the need to effect a large change in the area of the exit nozzle, a nominal figure for present-day units being about 70-80 per cent increase for a 45 per cent thrust boost.

Work on variable-area nozzles started at about the time when exhaust reheat was being applied to Welland turbojets. The thrust boosts were then in the region of 10 per cent and naturally the nozzle design was arranged to suit these conditions. The first design (Fig. 8) consisted of two narrow shutters which were arranged to operate in channels blended into the jet-pipe wall. Each shutter was offset on its shaft to balance the operating forces. It was found that in the closed position the angle of each shutter was sufficiently great to cause a vena-contracta effect in the nozzle mouth, thereby producing a smaller effective nozzle area than had been originally intended.

This effect was more fully investigated by fixing two flat plates, one at each side of the jet-pipe exit, so that each plate protruded into the issuing gas stream. The results of these tests on two pipes of different area are given in Table 3. The maximum effective-area changes were 16 per cent and 31 per cent respectively.

TABLE 3 Test results of flat plate nozzles.

	Standard Conv. Nozzle		Flat Plate Nozzle		Flat Plate Nozzle	
Actual area (sq in) ...	106		116		115	
Effective area (sq in)	106		106		106	
Maximum area (sq in)	—		124		137	
Speed (r.p.m.) ...	15,700	16,500	15,700	16,500	15,700	16,500
Thrust (lb)	1,150	1,350	1,160	1,380	1,120	1,355
Jet Temperature (deg C)	527	577	528	577	532	579

Based on this information, a nozzle (Fig. 9) was designed in which the two flat plates could be moved to and fro across the issuing jet stream. The two plates were formed to the shape of caliper arms and operated between two flanges on the nozzle body. Each arm was pivoted at opposite ends, the free end in each case being connected by a pin to a circular control ring around the jet pipe. Rotation of this ring caused the caliper arms to move in and out of the mainjet pipe, somewhat after the manner of a camera-lens diaphragm, thus varying the effective area of the final nozzle by 34 per cent. The total weight of this nozzle was 12 lb, excluding the external operating mechanism. Test runs without reheat showed that the effect due to the flat plates was negligible

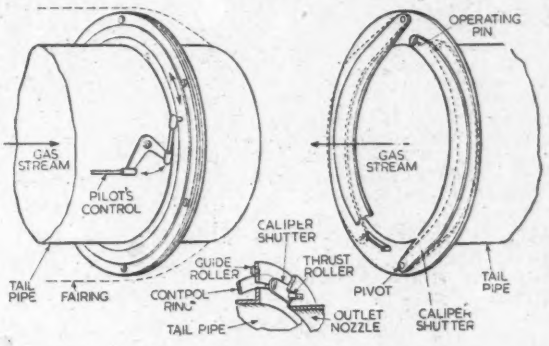


Fig. 9. Variable nozzle redesigned with caliper action.

when compared with a standard nozzle. Tests with exhaust reheat, in which the nozzle parts were heated to a bright red colour, had no effect on the mechanical operation.

Following the success of the caliper nozzle on the Welland unit, a design was put in hand to suit a larger reheat system. All major components were similar to those of the earlier design, except that it was designed to give an effective diameter change of 16in to 21in, which would allow a maximum thrust boost of at least 45 per cent on the system under consideration. The total weight of this prototype nozzle was 50 lb, although it was expected that some reduction could eventually be made by reducing the gauge of the material.

Future Prospects

Tests with reheat had shown that much development work still remained to be done before the nozzle could withstand the high temperature associated with 40-50 per cent thrust boost. Maximum boost reached so far has been in the order of 28 per cent. The loss in thrust when the nozzle was closed was about 2-3 per cent. Admittedly, this is high when viewed from a purely theoretical aspect, although some consideration must be given to the simple means of achieving such a large area-change. It has yet to be proved whether or not this can be done by other means having less adverse effect on performance.

An illustration of this nozzle, fitted to a typical reheat system, appeared in the heading to Part I of this article (p. 285, September 8th). The results obtained during the past two years have undoubtedly brought us within sight of the ultimate goal. A far better understanding of the combustion and mechanical problems involved has enabled us to define more clearly the future programme of work.

The point has now been reached where emphasis must be placed on development rather than on basic research, and the main object should be to develop a high-boost flight system with which to obtain experience at high altitudes and forward speeds. The results of this work may reveal other weaknesses which will require further basic research: it is essential, therefore, that these flight tests be initiated as soon as possible in order that any faults which become apparent may be tackled without delay.

Perhaps the most outstanding development problem is that of cooling. This not only affects the aircraft structure but complicates the design of the variable nozzle. It may well be that cooling will become the controlling factor on the amount of thrust boost that can be tolerated in an aircraft. This is a very important question, and one that requires an early answer.

[*The drawings accompanying this article are based on official illustrations, Crown copyright reserved.*]

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

RAPIDE REPLACEMENT

SINCE the B.E.A. Rapide replacement was first talked of, I have not heard a single mention of an aircraft which seems eminently suitable for the job—namely, the Merchantman.

The aircraft required is to have four Gipsy Queens. Fitted with these, the Merchantman was designed for a 5,000lb payload, or about 20 passengers. Carrying only 10 or 12 passengers—with a correspondingly generous baggage allowance—and with all that Miles flappery, it would seem to fit the 600-yard airfield case very nicely.

It has already some flying time behind it (wherever it is now) and it seems to be straightforward and strong—good for bumpy airfields—in the established Miles tradition. And Handley Page at Woodley could build it.

Unless B.E.A. have set their heart for good on a brand new design, the Merchantman does seem as worthy of mention as the Dove, Prince or Drover. R. GOADBY.

Northwood, Middlesex.

CHEAP AIR TRAVEL

I AM writing in support of Mr. Keegan's realistic letter (August 11th) as regard cutting out the frills of air travel in order to bring down fares to a level within the means of the man in the street.

From the outset airlines seem to have been under the impression that a passenger regards travelling by air as an attraction in itself, rather than as a means to an end, namely to get from A to B in as short a time as possible.

Also, in these days of high taxation (a proportion of which is attributable to the losses of our nationalized airlines) would-be passengers are more inclined to favour lower fares than super first-class luxury, and the sooner the inter-continental corporations realize that it is possible to make passengers comfortable and satisfied without providing them with small-sized settees (in lieu of seats), cocktail bars, etc., and utilize the space (and payload) made available by their removal in increasing the seating capacity, the sooner they will be able to reduce fares, thereby increasing load factors and perhaps at some future date emerging from the red.

No doubt Mr. Geoffrey Dorman is correct when he states that the people of Uganda and Rhodesia find it cheaper to travel to the U.K. by air rather than by rail and sea. That is their good fortune, but Mr. Dorman's reputation for accuracy is not enhanced by his omission of the fact that these people do not pay the full fare. The rest must be met by the British taxpayer at the end of each fiscal year!

Sunbury-on-Thames, Middlesex. POTENTIAL PASSENGER.

BACK TO NATURE ?

ALL your correspondents who have been criticizing Mr. Thomas D. Keegan's letter about high airline fares seem to overlook—just as does Mr. Keegan himself—the basic truth of the whole matter, which is one that you, Mr. Editor, will probably not be willing to print.

In short, it is that flying is an unnatural (or, if you like, unmechanical) method of transport and will never, now or at any time in the future, become an economical proposition.

Modern aircraft are fantastic masses of dangerous complication, and use power out of all proportion to their load-moving ability. A railway engine of about 1,500 h.p. moves 600 or more passengers in safety and comfort; an airliner, running on a lethal fuel, requires about three times that power to move one-thirtieth the number! Just to keep it in the air, the airliner needs an incredible organization of weather experts, control officers, radar, radio and other communications apparatus and, for landing or taking-off by night, enough light to illuminate a small town. And if any one of these human or mechanical brains fails for a few seconds, all sorts of serious possibilities loom up. Compare this with the foolproof "ground" organization required for operating trains and ships—always essentially simple, and only on a large scale because there are so many hundreds of thousands of trains and ships to be controlled.

Your readers will probably tell me that the far greater speed of aircraft more than cancels-out all my objections. But what virtue is there in speed for its own sake, the curse of modern so-called civilization? Most of these airline passengers only use the time gained to drink, in Paris, or New York, or wherever it is, the same drinks that they would be drinking at home if they didn't fly at all; or perhaps to beat the other chap to it on a business deal—an advantage which they could take equally well by telegraph, train or ship if there were no such things as airlines.

No, to my mind, aircraft should be reserved for their only real use—as weapons of war. In war, nothing is considered too wasteful or fantastic, and none of my objections would apply. SOUNDPROOF.

London, S.W.1.

AWARDS TO INVENTORS

YOUR paragraph (August 25th) on the Air Ministry scheme for awards and recognition for those in the Service who submit ideas and inventions is good news. It is a step forward in ensuring a fair deal for Service personnel, because it has been the experience of a good many that ideas and inventions which they have submitted have been turned down, only to "arrive" in service at a later date.

The legal position of a serviceman who proposes an invention is still most unsatisfactory, however; when the proposer attempts to obtain recognition, the Government department concerned need not deal properly with his representations—he can be told that under Head iii of its terms of reference, the Royal Commission on Awards to Inventors may enquire into the circumstances of his case if it is referred on behalf of the Treasury by the department concerned.

Thus, for inventions relating to aircraft, the Ministry of Supply is responsible for receiving, investigating and using inventions, and if it turns them down but they arrive in service, it has the power to refuse, and does refuse, to refer such cases to the Royal Commission on Awards to Inventors to be dealt with on the evidence.

A Government department thus plays the part of judge in a disagreement in which it is one of the parties!

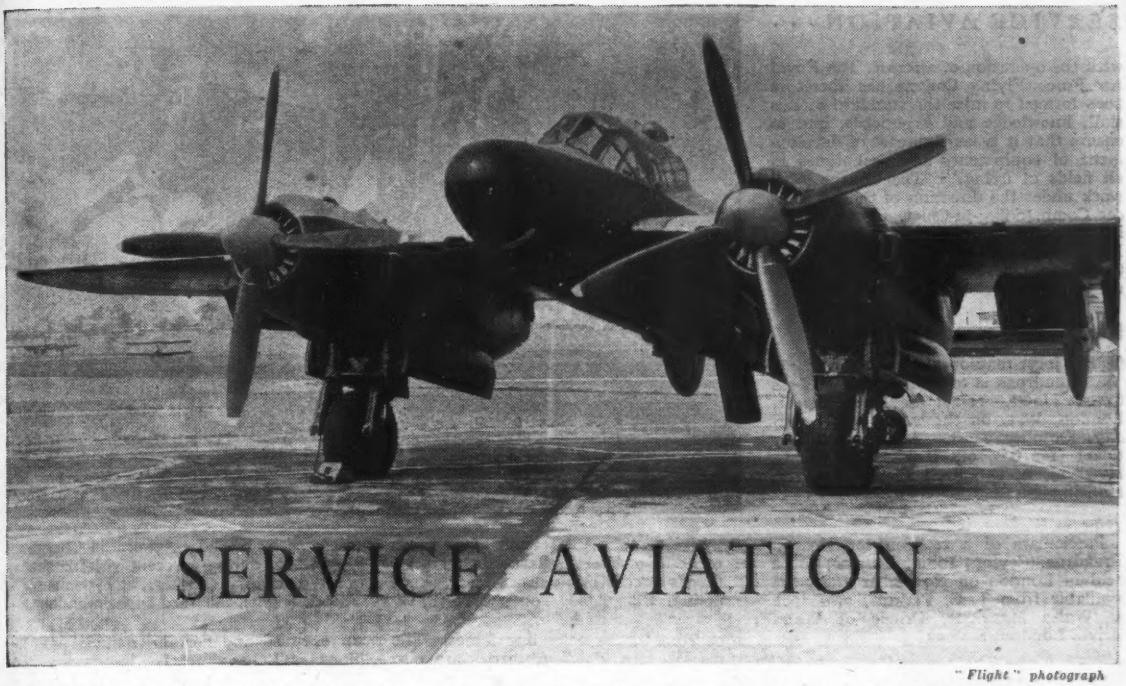
Serving and ex-serving personnel should have the right to be able to take their cases before the Royal Commission on Awards to Inventors which has been set up for the purpose, and the amendment of the regulations to allow this would ensure common justice, whilst also being an incentive to recruitment. I suggest the Staff Suggestions Committee of the Air Ministry Departmental Whitley Council could make a good start to their work by getting cracking on this.

London, N.W.6. J. R. ANDERSON,

(Late Flight Lieutenant, D.F.C., A.R.Ae.S.)

FORTHCOMING EVENTS

Sept. 15.	R.Ae.S.: Fifth British Commonwealth and Empire Lecture, "Inter-City Transport Development on the Commonwealth Routes," E. H. Atkin, F.R.Ae.S.
Sept. 20.	Aero Golfing Society: Autumn Meeting, Richmond Golf Club, Sudbrooke Park.
Sept. 21.	R.Ae.S. (Reading): "Servicing and Maintenance of R.A.F. Aeroplanes," S/L. E. A. Harrop, O.B.E., A.F.R.Ae.S.
Sept. 24.	Helicopter Association: "Helicopter Economics," L. S. Wigdortchik, A.F.R.Ae.S. Evening: Annual Dinner.
Sept. 24.	R.N. Air Station, Yeovilton: Air Display.
Sept. 28.	R.Ae.S. (Weybridge): "Do Scientists know Anything?" C. G. Grey.
Oct. 1.	British Interplanetary Society: Conversazione.
Oct. 5.	R.Ae.S. (Luton): Film Show.
Oct. 19.	R.Ae.S. (Reading): "Atomic Energy," A. G. Salmon, B.Sc., A.Inst.P.
Oct. 19.	R.Ae.S. (Weybridge): "Aircraft in Future Warfare," Air Marshal Sir Robert Saundby, K.B.E., C.B., M.C., D.F.C., A.F.C.
Nov. 2.	R.Ae.S. (Luton): "Gas Turbine Development."
Nov. 9.	R.Ae.S. (Weybridge): "The Brabazon I," F. H. Pollicut, F.R.Ae.S.
Nov. 19.	British Interplanetary Society: Symposium, "Medical Problems of Space Travel."
Nov. 23.	R.Ae.S. (Reading): "British Airships," Lord Ventry.
Nov. 23.	R.Ae.S. (Luton): Brains Trust.
Nov. 30.	R.Ae.S. (Weybridge): "Radar and Aircraft," B. W. Hodlin, B.Sc.
Dec. 3.	British Interplanetary Society: Film Show.
Dec. 7.	R.Ae.S. (Reading): "Forty Years of Aviation," Sir Frederick Handley Page, C.B.E., F.R.Ae.S.
Dec. 7.	R.Ae.S. (Luton): "Aircraft in Future Warfare," Air Marshal Sir Robert Saundby, K.B.E., C.B., M.C., D.F.C., A.F.C.
Dec. 9.	British Interplanetary Society: Annual General Meeting.
Dec. 21.	R.Ae.S. (Weybridge): Films by W. Courtenay, M.M., R.Ae.S.



"Flight" photograph

OFFENSIVE: In keeping with its rôle as a long-range dive- and ground-attack bomber, the Bristol Brigand B.1 is seen to have a particularly fierce appearance, even without the 3,200lb of bombs which may be carried externally under wings and fuselage. Two fan-cooled, 2,810 h.p. Centaurus 57s power the Brigand, now going into service with squadrons overseas. Its maximum speed is 357 m.p.h.

Air Memorial

A MEMORIAL chapel to 90 airmen of the British, Dominions and U.S. Air Forces who were stationed at Cottesmore, Rutland, and lost their lives in the war, was dedicated in Cottesmore parish church on September 8th. A.V-M. the Rev. Leslie Fright, the R.A.F.'s Chaplain-in-Chief, gave the address.

R.A.F. Appointments

AS briefly recorded in the previous issue, A.V-M. R. M. Foster, C.B., C.B.E., D.F.C., has been appointed to succeed Air Marshal Sir Alan Lees, K.C.B., C.B.E., D.S.O., A.F.C., as A.O.C.-in-C., Reserve Command. From October 1st, the effective date of his appointment, he takes the rank of air marshal.

A.V-M. Foster was Assistant Chief of Air Staff (Policy) from February, 1947, until recently and was formerly A.O.C., No. 3 Group, Bomber Command, to which he went in July, 1946, after having been A.O.C. R.A.F. Austria, and Chief of the Air Division, Control Commission for Austria (British Element) from August, 1945. In 1939 he was a wing commander serving in the Air Ministry Directorate of Plans. Almost immediately after the outbreak of the war he was posted to Bomber Command, in which he was successively S.A.S.O., No 2 Group, commanding officer of No. 110 Squadron, and station commander of the bomber station at Wyton until July, 1941, when he went to R.A.F. Middle East H.Q. In January, 1942, he was given command of No. 214 Group in Iraq, and later of No. 213 Group, in the Levant. Towards the end of 1942 he became S.A.S.O. at Air Headquarters, Caucasia, with the acting rank of air commodore, and in September, 1943, after having been head of a special planning staff at Mediterranean Air Command Headquarters for six months, he went to Italy with the Allied Control Commission. He was afterwards A.O.C., Malta, with the rank of air vice-marshal, from March, 1944, and was later A.O.C., Desert Air Force from the following December until he went to Austria. He was promoted to the substantive rank of air vice-marshal in October, 1946.

Also announced is the appointment of A. Cdre. S. N. Webster, C.B.E., A.F.C., as S.A.S.O. at Coastal Command H.Q., with the acting rank of air vice-marshal. Until recently, A.V-M. Webster has commanded the R.A.F. Central Photographic Establishment, to which he went in November, 1948, after his return from Hong Kong, where he was A.O.C. for two years.

A.V-M. Webster is 49 and was commissioned in the R.A.F. in 1918 after serving in the Army for some months. In 1927, when a flight lieutenant, he won the Schneider Trophy for Great Britain, flying at a speed of 282 miles an hour in a Supermarine Napier Monoplane. This was the first of three successive victories that won the trophy outright for this country in 1931.

Royal Air Force and Naval Aviation News and Announcements

Empire Schools United

THE three R.A.F. Empire Schools, those of Flying, Air Navigation and Air Armament, are being amalgamated to form the R.A.F. Flying College at Manby, Lincs, which will open next January. The new College will give selected officers practical instruction and experience in a combined course of flying, navigation and the use of weapons in all-weather conditions. It will also undertake investigations to keep techniques abreast of technical development, thus enabling teaching to be kept up-to-date.

The "Empire" outlook of the three schools which have pooled their knowledge and resources to form the new Course will be retained by Commonwealth representation on the instructing staff and on the Course. The three aspects of flying, navigation and armament have now become so closely interrelated that the R.A.F. officer who will captain aircraft and command the squadron of the future must be thoroughly trained in all three aspects if he is to fly his aircraft or command a squadron to the best advantage.

Each Course, of about 30 officers, will last 12 months, during which students will study the theory of combatant flying and will practice, on the latest types of aircraft, the most up-to-date techniques of high-altitude, high-speed, all-weather flying, navigation and the use of weapons. During the later stages of the Course students will fly to various parts of the world to undertake such work as the study of flying in tropical and arctic conditions. They will also spend periods at experimental establishments following the progress of specific scientific projects.

An official description of the College's aim states: "The fighting efficiency of the Royal Air Force derives in special measure from the personal skill, knowledge and experience of those who command flying units or who are concerned

SERVICE AVIATION . . .

with the operation of aircraft. The Royal Air Force Flying College has therefore been formed to raise the standard of this skill, knowledge and experience, and to ensure that it is kept abreast of development of equipments and techniques in all fields of flying." The College will work under the direction of the Air Officer Commanding-in-Chief, Flying Training Command, Air Chief Marshal the Hon. Sir Ralph A. Cochrane, with Air Commodore A. McKee as its first Commandant.

Reunions

THE joint reunion of Nos. 462 and 466 Squadrons is to be held at the Rose Court Hotel, 11-17, Seymour Street, London, W.1, on the evening of Saturday, October 22nd. Admission is by ticket (12s 6d), obtainable from W. L. Harrison, 6, Cromwell Place, St. Ives, Huntingdon.

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Particulars of a reunion for No. 30 Squadron (Ceylon, India, Burma), to be held in London on November 19th, are available from J. C. Perkins, 7, Prince of Wales Mansions, Prince of Wales Drive, London, S.W.11.

Exercise "Bulldog"

IN contrast to Exercise *Foil*, the full-scale test of Britain's air defence system which was held earlier this summer, the operational exercise to be staged later this month by the R.A.F., under the code-name *Bulldog*, is designed primarily to give experience to Bomber Command in day and night attacks on defended targets.

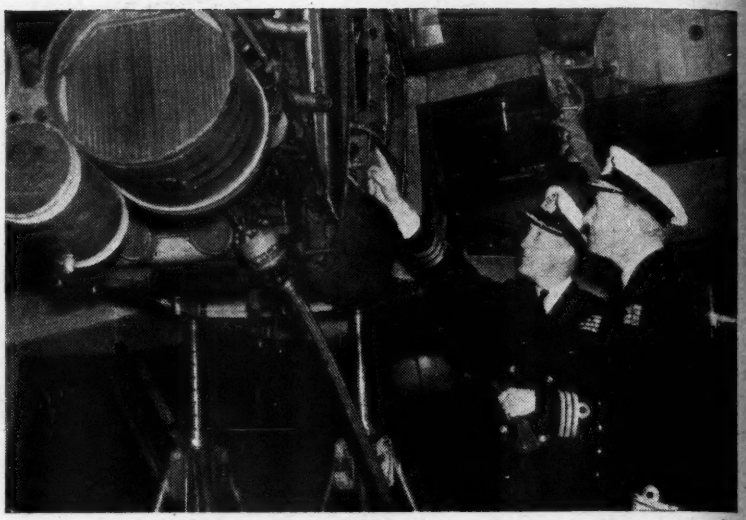
The United States Air Force and the Royal Netherlands Air Force will again co-operate and, for the first time since the war, aircraft from France and Belgium will take part in an R.A.F. exercise. They will contribute fighter squadrons to the defending forces. The three Western Union countries are also providing control and reporting personnel to help man the radar stations. Another new feature will be the manning of a complete fighter sector by 300 volunteers of R.Aux.A.F. fighter control units. They will be flown from their home towns all over the country to a fighter sector in the South-West to do a 24-hr spell of duty.

Most raids will be routed to avoid, as far as possible, the air and ground defences, although special measures will be taken to give practise to as many as possible of the defence elements deployed. Although having a bomber bias, *Bulldog* will also be of great value in exercising the air defences. It will essentially be an exercise and certain artificial conditions will have to be imposed. No attempt will be made to determine the superiority of the attacking or defending forces. The exercise will be under the general direction of Air Marshal Sir Aubrey Elwood, the Air Officer Commanding-in-Chief, Bomber Command, who will also command the R.A.F. attacking forces.

The main attacking force will consist of Lincoln, Lancaster and Mosquito squadrons of Bomber Command, Mosquito squadrons of the British Air Forces of Occupation, Germany, and B-29 and B-50 Groups of the Third Air Division of the U.S.A.F., under their Commanding General, Major General Leon W. Johnson. For the purposes of the exercise, Hornets will be drawn from Fighter Command to operate with the attackers, and some Meteors will simulate high speed jet bombers. Opportunity will be taken also to give practice to certain pupil and instructor crews of Flying Training Command. These crews will operate in aircraft appropriate to the stage of their training—Lancasters, Mosquitos, Ansons, Harvards and Prentices. The experience they will gain in taking part in a full scale operational exercise will be of great training value.

Defences will be commanded by Air Marshal Sir Basil E. Embry, Air Officer Commanding-in-Chief, Fighter Command. In addition to Regular fighter squadrons, they will comprise flying squadrons of the R.Aux.A.F., a number of French, Netherlands and Belgian fighter squadrons, and Regular and Territorial Regiments of Anti-Aircraft Command, under their General Officer Commanding-in-Chief, Lieutenant-General Sir G. Ivor Thomas. R.A.F. control and reporting units and the Royal Observer Corps will also be on duty. Non-regular formations will be deployed only on Saturday and Sunday.

Bulldog will start at 1900 hr on Friday, September 23rd, and is planned to end at dawn on Tuesday, September 27th, but if the problems involved are adequately covered in the early stages, it may be curtailed by 24 hours.



IN RESERVE : A Barracuda under repair is inspected by the Rear-Admiral in Charge of Reserve Aircraft, Rear-Admiral (E) W. S. Jameson, during a recent visit to the Navy's aircraft maintenance yards, which employ 700 civillian workers, at Sydenham, Belfast. His guide is Commodore (E) G. W. Alcock (right), the Yard Superintendent.

CHANGED VIEWPOINT : Members of the Royal Observer Corps, whose vigilance in spotting aircraft from the ground plays an important part in the air defence system, are shown entering a Dakota for flight experience. The occasion was their annual camp at Thorney Island, inspected by the Air Minister last Friday.